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# WESTERN GREAT LAKES DRAINAGE BASIN. A COOPERATIVE STATE-FEDERAL REPORT ON WATER POLLUTION

Public Health Service
Chicago, Illinois

1951

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*For Clean Water—"One River, One Plan"*

# Western Great Lakes
# DRAINAGE BASIN

## A COOPERATIVE STATE-FEDERAL REPORT ON WATER POLLUTION

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FEDERAL SECURITY AGENCY

Public Health Service

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SUMMARY REPORT ON WATER POLLUTION

# *Western Great Lakes Drainage Basin*

Prepared by

FEDERAL SECURITY AGENCY
Public Health Service
Division of Water Pollution Control
Upper Mississippi and Great Lakes Drainage Basins Office

1951

In cooperation with:

Illinois Sanitary Water Board
Indiana Stream Pollution Control Board
Michigan Water Resources Commission
Minnesota Department of Health
Wisconsin Committee on Water Pollution

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# INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June of 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies, and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters.

In developing these programs, due regard must be given to improvements necessary to conserve the Nation's waters for public water supplies, propagation of fish and aquatic life, recreational purposes, agricultural, industrial, and other legitimate uses.

Recognizing the fact that full technical information was not available to permit the development of such comprehensive programs immediately for most of the Nation's waters, the Public Health Service envisioned the development of these programs in two general phases. The first phase contemplated the development of a series of reports, consistent with presently available data, which would: provide a reference point for measuring progress; provide a guide to needed additional data; provide a basis for the logical development of comprehensive programs; provide a basis for approval of loans to States, interstate agencies and municipalities at such time as the Congress made available funds for this purpose; and serve to inform the public on the problem of water pollution and set forth suggestions for pollution control.

The collection of available data as of July 1, 1950, has been completed under the first phase of the program. Such data have been assembled with the cooperation of State and interstate water pollution control agencies. Through these agencies additional data have been obtained from other State officials, county and city officials and representatives of industry. Federal agencies also have been of great assistance. In order to make this information available at the earliest possible moment, these data are being presented in 15 summary-type reports covering the United States by major drainage basins. This report on the Western Great Lakes Basin is one of that series.

These summary reports present information about the ways our water resources are used, the pollution going into our water resources and the resulting damages, the benefits which may result from pollution prevention and abatement, the pollution prevention measures now in effect, and those required.

They are prepared in two parts. Part one considers the water pollution problems of the basin as a whole. Part two presents briefly the data for each of the several sub-basins of the major basin, including a list of projects now known to be needed for water pollution control.

Since the summary reports are based on data which are now readily available, these reports do not discuss or evaluate the most advantageous water uses as they are related to pollution control. Such considerations will be included as a part of the comprehensive water pollution control programs.

The deficiencies in data and the gaps in information indicated in these summary reports are as significant as the presentation of available facts and statistics. They indicate the work which still needs to be accomplished by water pollution control authorities for the preparation of comprehensive programs.

Data and knowledge now available are sufficient, however, to permit the immediate solution of many of the pollution problems within the Western Great Lakes Basin without awaiting the results of additional surveys and studies. The tabulations of pollution abatement projects which are included in Part Two of this summary report represent presently known needs. However, future studies and evaluations may result in some changes in the estimations of requirements.

A sincere effort has been made by all who contributed to this report to present a fair picture of the complex water pollution problems in the Western Great Lakes Basin and to present reasonable conclusions and recommendations. It is our hope that this report, as a step in the cooperative development of an ultimate comprehensive pollution control program, will help in safeguarding the water resources of the Western Great Lakes Basin.

Leonard A. Scheele

Surgeon General



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## ACKNOWLEDGMENTS

The Public Health Service wishes to acknowledge the full cooperation received in the preparation and review of this report from the following State agencies in the Western Great Lakes Drainage Basin: the Illinois Sanitary Water Board, the Indiana Stream Pollution Control Board, the Michigan Water Resources Commission, the Minnesota Department of Health, and the Wisconsin Committee on Water Pollution.

Acknowledgment is also made of the cooperation of the personnel of the State Boards (or Departments) of Health of the States mentioned, and of useful data obtained from publications of the Michigan and Wisconsin State Planning Boards.

Federal agencies from whose reports data were obtained include the Bureau of the Census, Department of Commerce; the Corps of Engineers, Department of the Army; the Fish and Wildlife Service and the Geological Survey, Department of the Interior; the Department of Agriculture; the National Resources Committee; the National Resources Board, and the International Joint Commission.

Finally, there is acknowledged the assistance of other State agencies and individuals interested in water resources development and conservation, that have contributed information through sources other than those listed above.

## SUMMARY


Although the Great Lakes Drainage Basin contains five great lakes, for administrative purposes this report concerns itself with only the three western and largest of the group (Lakes Superior, Huron, and Michigan, and the American portion of the Basin tributary to them including the Lake Huron-Lake Erie Waterway), and is accordingly published as a report on the Western Great Lakes Drainage Basin. Lake Erie is considered in a separate report, and Lake Ontario in the report of the North Atlantic Drainage Basins.

All of the State of Michigan and parts of the States of Illinois, Indiana, Minnesota, and Wisconsin are in the Western Great Lakes Drainage Basin. Chicago and the metropolitan communities, which are within the Sanitary District of Chicago, are not included in the data even though they are topographically in the Basin. Since all drainage from these communities is to the Mississippi River through the Illinois River system, they are reported upon in the Upper Mississippi River Basin Summary Report.

The Western Great Lakes Drainage Basin has a tributary land area of 94,000 square miles in the United States alone. The population of this area was approximately 8,969,000 in 1950, exclusive of the Sanitary District of Chicago, the concentration varying from very sparse in the northern rural areas to very dense in the industrial centers.

The water resources of the Great Lakes Drainage Basin are among the world's greatest. Nature has endowed this area with two large natural fresh water reservoirs unequalled anywhere--the Lakes themselves, and the enormous ground water reservoir in the permeable soil. Although there has been some exploitation of the natural resources within the Basin, it still offers great opportunities for continued development as an industrial and recreational area.

Nearly all of the recognized legitimate water uses are represented here, the more important being municipal water supply, industrial water supply, recreation, navigation and commercial and sports fishing. The abundance of good quality ground water over much of the area has resulted in its widespread use for domestic and industrial purposes, although the surface waters are also used for these purposes especially in the concentrated population centers. The fact that recreation, in addition to agriculture, has become one of the more important industries emphasizes the significance of the uses of surface water for these purposes in the rural areas.

Although the damage to the water resources has not been widespread, the problem of pollution is acute in many localized areas. The principal damage has been to domestic water supplies although the other uses have been damaged in varying degrees. The State water pollution control agencies have recognized the existing as well as the potential problems and have been active in the control of pollution. Many of the problems have interstate and international aspects. The States have recognized this problem, however, and have cooperated with their neighbors on the problems often without legal formalities. The international problems have received attention principally through close cooperation with the International Joint Commission.

The tables contained in this report have been developed from basic data supplied by the cooperating water pollution control agencies. Attention is invited to the fact that these data were drawn from their files and represent material readily available. Some of the information is preliminary in nature and time did not permit field checking by the water pollution control agencies so it does not represent their final judgment on needs. No conclusions may be drawn from the relative lengths of Table I, therefore, since additional field investigations will undoubtedly cause changes to be made in these lists.

An analysis of the available data reveals that there are 610 municipal sources of pollution with sewerage systems serving 6,930,000 people. The importance of industrial waste discharged to municipal sewerage systems is evidenced by the fact that although many municipalities are providing excellent treatment of the combined wastes (up to 90 percent or more reduction in B.O.D.), the quantity of discharge to the streams in terms of population equivalent still exceeds the population served.

Of the municipal sources of pollution, 210 had 1940 populations of 2,500 or over including several very large cities, 152 had populations between 1,000 and 2,500, 98 had populations between 500 and 1,000, and 150 had populations less than 500. In many instances the extent to which these populations are served by sewers is unknown. In some cases the discharge to the stream is so small that no physical damage is apparent.

There are 783 known industrial sources of pollution which discharge directly to the watercourses in the basin, 311 of which produce organic waste.

Tables A and B show the number of known sources of pollution, but make no attempt to

differentiate between those which have satisfactory treatment and those that do not have satisfactory treatment. Reference to tables C, D and E, however, shows that there are 313 municipal sewage treatment plants serving about 5,700,000 people although only 192 have adequate capacity to be completely satisfactory. Of the 142 municipalities not included with those reported as having satisfactory treatment, 60 had 1940 populations of 2,500 or more, 32 had populations between 1,000 and 2,500, 23 had populations between 500 and 1,000, and 27 had populations under 500. These tables also show that 281 of the 779 industries have provided treatment of some sort although only 168 have adequate capacity. In addition 37 municipal and 31 industrial waste treatment plants are producing poor effluents due to improper operation.

Much needs to be done to abate the existing pollution but the picture is by no means dark. In recent years public interest in the problem has been increasing and municipal and industrial leaders are becoming more receptive to pollution abatement plans. During the years 1946 to 1949, 30 municipal and 86 industrial waste treatment plants were completed in the Western Great Lakes Drainage Basin, 13 municipal and 34 industrial waste treatment plants being completed in the year 1949 alone. In addition, the interest of the public in the problem is evidenced by the strengthening of water pollution control laws by all of the States in the basin, and an increase in the State funds allotted for water pollution abatement activities.

The State water pollution control agencies have been very active for many years and deserve credit for the progress made, especially in recent years in the face of the difficult postwar construction period. Table G shows that there is a backlog of needed work if existing pollution is to be abated. One hundred and eighty-seven new municipal and 104 new industrial waste treatment plants are required. In addition 84 municipal treatment plants need enlargements or additions and 23 need to be replaced. In the case of industry, 58 of the existing waste treatment plants are in need of enlargements or additions and 19 need to be replaced. The waste treatment requirements for 30 municipalities and 415 industries are still undetermined. An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

| Population group | New plant | Enlargement or additions to existing plant | Replace existing plant | Undetermined |
|---|---|---|---|---|
| Less than 500..... | 29 | 8 | 5 | 9 |
| 500 to 1,000 | 31 | 5 | 9 | 6 |
| 1,000 to 2,500... | 64 | 21 | 4 | 11 |
| Over 2,500 | 63 | 50 | 5 | 4 |
| Total.... | 187 | 84 | 23 | 30 |

On July 1, 1950, 19 municipalities and 19 industries had waste treatment facilities under construction. In addition to the above 176 municipalities and 98 industries were in various stages of planning preparatory to the construction of needed facilities. Sixty-six municipalities and 43 industries were under order to abate pollution. The number of orders issued, however, does not reflect a fully accurate picture of State activities, since it is the policy of some States to avoid formal orders in favor of an informal approach to the problems.

The cost of needed facilities has been extremely difficult to estimate. From the data available, however, it is estimated that the necessary municipal treatment facilities will cost approximately $95,000,000 and the cost of industrial waste treatment facilities is estimated to equal or exceed this amount. Attention is invited to the fact that these figures are necessarily rough estimates and do not include estimates for any of the 30 municipalities and 415 industries whose needs were undetermined at the time this report was written. The inclusion of this undetermined group plus the cost of intercepting sewers will, of course, result in a considerably higher overall cost.

The pollution control laws of the States in this basin are good workable laws and it is not anticipated that major additional enforcement legislation will be needed in the near future.

Financing of the needed pollution abatement facilities is a serious problem. Frequently municipal officials are aware of the pollution caused by their municipalities and desire to abate this pollution but are hesitant to proceed with the problems of financing. Experience has shown, however, that municipalities, with the exception of very small towns have been successful in completing projects with reasonable service charge or tax levies.

## CONCLUSIONS

From a review of the data, it is concluded that:

1. The water resources of the Western Great Lakes Drainage Basin are of great value to the area and have been responsible to a large extent for its economic growth. Although the water resources are abundant, they are not unlimited and must be conserved.
2. The waters of the Basin are polluted in varying degrees. In many localities, pollution of the water has resulted in serious damage to legitimate water uses.
3. The pollution of water, especially in the more critical areas, is interstate and even international in scope. The cooperation of the various governmental agencies concerned with such problems has been excellent.
4. The data on the pollution load contributed by municipalities and industry to the streams and the extent to which water uses have been damaged are incomplete. However, enough information is presently available to permit the State pollution abatement program to operate effectively.
5. New waste treatment facilities are required for a large number of municipal and industrial sources of pollution. In addition, many existing waste treatment facilities are in need of replacement, additions or alterations.
6. Operation of existing waste treatment plants is generally very good, but in a few cases the facilities are not being utilized in a manner to accomplish the objective for which they were designed and constructed.
7. The States in the Basin have workable water pollution control legislation and good, although small, technical staffs. The work load is so large, however, that the small staffs are not able to do all the necessary work. More funds and equipment are necessary to adequately prevent and abate pollution. State Civil Service regulations setting unrealistic maximum salary limits have also prevented some State agencies from attracting additional experienced personnel.
8. Financing of the needed municipal pollution abatement facilities is a serious problem, and there is a need for legislation which will improve the ability of the municipalities to finance the needed facilities.
9. A broad information and education program is needed in order to advise the people of the essentiality of pollution prevention and abatement and the benefits to be derived from such action.

## RECOMMENDATIONS

It is recommended that:

1. Waste treatment be provided by all municipalities and industries to the degree necessary to prevent damage to legitimate water uses.

2. The maintenance and operation of existing municipal and industrial waste treatment plants be sustained at a high level in order to utilize fully the facilities designed to eliminate or reduce the amount of polluting material being discharged to the watercourses.

3. The State governments within the Basin energetically support the State water pollution control program through the provision of adequate funds, staffs and equipment. Where State Civil Service regulations on salary limitations are a deterrent to the employment of experienced personnel, suitable legislation to remove this obstacle should be sought.

4. Where necessary, steps should be taken at the State level to develop legislation intended to improve the ability of municipalities of the various States to finance the needed pollution abatement facilities.

5. The State water pollution control agencies expand their information and education programs in cooperation with State, municipal and private water use agencies in order to stimulate greater interest in pollution abatement.

6. The State water pollution control agencies aggressively pursue investigative and survey programs in order to determine:

   (a) The location of each source of pollution and the loading from certain sources where this information is pertinent;

   (b) The extent to which the present water uses have been damaged, and

   (c) Action necessary to obtain the quality of water necessary for the legitimate water uses.

# LOCATION MAP

*Western Great Lakes Drainage Basin*

# GENERAL DESCRIPTION

## Historical Background

Lake Huron was the first of the Great Lakes to be discovered by the white man, according to early records. Champlain, the founder of Quebec and "Father of New France," on a journey to establish new Indian trade, emerged from the mouth of the French river and discovered Lake Huron in July 1615. In his journal he writes, "because of its great size, I named it the fresh water sea," but little did he know that what lay before him was a bay, now known as Georgian Bay, which is but an arm of this great lake.

There is some doubt, because of the lack of adequate records, concerning the identity of the discoverer of Lake Superior, the largest body of fresh water in the world. Notations of the missionaries among the Huron Indians have led certain historians to credit discovery of Lake Superior, about 1623, to E. Brule and Grenoble. These notes mentioned the reports of these two men, "that there was another very great lake" above Lake Huron.

Lake Michigan was discovered in 1634 by Jean Nicolet, who was in search of a water route to China. According to the records, he carried with him a gorgeous robe of China damask to wear when he greeted the oriental monarch. His travels carried him through the Straits of Mackinac, and, continuing west, he landed on the shores of Green Bay. Following his return to Quebec, he had to admit failure to accomplish his assigned mission, however, he was able to announce discovery of the area now known as the State of Wisconsin.

While the search for a water route to the Far East led to the above discoveries among others, water transportation has also been a dominant feature in the economic development of the area. Its great harbor cities grew because of the need for the collection and/or distribution of the cargoes carried by the lake vessels.

When the early explorers first visited the Basin, they found a virgin wilderness with a varied and valuable stand of timber, The forests and streams were teeming with furbearing wildlife and it was this great resource which attracted the early fur traders.

For nearly 200 years after its discovery there was very little development of the area. The expansion of the country following the Civil War created a demand for lumber. The vast resources of timber in this area and the availability of streams and lakes for easy transportation to sawmills and thence to markets resulted in an immediate and devastating attack on this great natural resource.

By 1900 most of the pine was gone, and by 1920 the cream of the hardwood was likewise depleted. The great forests of yesteryear gave way to the demands of man and the fruits of his carelessness--the forest fire. Today we have a monument to this attack, known as the "Northern Lake States Cutover Region."

Except for an area in Lower Michigan and another along the west shore of Lake Michigan, agriculture has never been very successful, but the availability of good transportation, population concentrations and convenient raw materials have resulted in great industrial centers. The history of the present generation probably will describe the area as a number of great industrial centers with recreational development in the rural areas--unless man has failed to learn his lesson and ruins another natural resource, water, by pollution.

## Physical Description

It is said that there is no other region in the United States where the water resources are so abundant and offer so much for the future as they do in the Great Lakes region. Nature has endowed this area with two large natural fresh water reservoirs unequalled anywhere--the Lakes themselves and the enormous ground water reservoir in the permeable soil.

Physically this drainage Basin is unique in that 39 percent of the total area of 140,000 square miles in the American portion of the Basin is occupied by the lakes themselves. The lake beds are cut deeply into the earth's crust, some of them to a point well below sea level.

These vast bodies of fresh water are not duplicated elsewhere in the world and, prior to their discovery, it was difficult for the early explorers to give much credence to the Indian tales concerning the lakes.

Lake Superior, the largest of the group, is about 350 miles long and has an area of 31,800 square miles. In places it is over 1,000 feet deep, the bed being 400 feet below sea level.

Lake Huron, the second largest, is about 200 miles long and has a maximum width of about 100 miles. Its area, including Georgian Bay, is 23,000 square miles. The depth is about 700 feet and the bottom is 120 feet below sea level.

Lake Michigan, the third largest lake and the only one entirely within the United States, is about 300 miles long and has an average width

of about 60 miles. It has an area of 22,400 square miles and a maximum depth of 870 feet.

The land area draining to the lakes is a gently rolling series of hills and depressions resulting in numerous small inland lakes in addition to the Great Lakes themselves. Most of the region ranges from 800 feet to 2,100 feet above sea level. The surface of the lakes themselves is approximately 600 feet above sea level. The region is covered by a thick mantle of glacial drift, and the soils and topography are typical of a glaciated country--a confused mixture of clay, light loam, and sand, with much more sand than clays; swamps and ridges; gravelly moraines and pine plains; and in certain areas, fertile soils.

The Lake Superior region has a continental climate, characterized by wide variations in temperature, normally ample summer rainfall and a general tendency to extremes in all climatic features. The average January temperature in the Lake Superior Sub-Basin will range from 6° to 14°F., while the corresponding July temperature will range from 60° to 64° F. The average annual precipitation in the region is from 28 inches to 32 inches and the annual evaporation is approximately 18 inches.

In the Lake Michigan-Huron watershed two distinct types of climate are observed--the continental and the semi-marine with changing meteorological conditions. The marine type of climate is due to the influence of the lakes, which in turn is governed by the force and direction of the wind. When there is little or no wind the weather becomes continental in character, and a strong wind will transfer the weather to a semi-marine type. The annual precipitation is from 28 inches to 35 inches and the mean annual evaporation is about 20 inches.

The streams of this Basin receive a large portion of their total flow from ground water and run-off from the numerous natural lakes which dot the area. The run-off of these streams is not large, being generally from 10 inches to 15 inches per year, but is reasonably uniform. The streams have generally uniform slope with few abrupt falls. Characteristic of the area are the many natural lakes which are proving to be a great economic resource of the area as a tourist attraction.

While there are wide variations in depth and permeability of soil, yet generally speaking, ground water is obtainable almost anywhere, in large or small quantities, in shallow wells. It forms, therefore, an important natural resource and throughout much of the area is so close to the surface as to be readily within the reach of deep-rooted trees and certain agricultural crops.

In the southern peninsula of Michigan the principal waterbearing formation is the glacial drift. The Saginaw sandstone is next in importance, with the Marshall sandstone third in water yield.

The natural outlet of the Chicago River was directly into Lake Michigan prior to 1900. However, since the stream carried nearly all of the untreated sewage and industrial wastes of the city directly into the lake, the safety of the water supply, which was obtained from Lake Michigan, was seriously endangered. In fact, one very serious typhoid outbreak in Chicago was attributed to pollution of the water supply by this source of pollution. Consequently, in 1889, the Sanitary District of Chicago was established for the purpose of diverting the sewage of Chicago and adjacent municipalities from Lake Michigan. Accordingly, the Chicago Sanitary and Ship Canal was constructed, being completed in 1900 and extending from Damen Avenue in Chicago to Lockport, Ill. a distance of 28 miles. Diversion from Lake Michigan is controlled at three points and is limited by a U. S. Supreme Court decree to an average annual rate of flow of 1,500 cubic feet per second. Since the sanitary and industrial wastes of the entire Sanitary District of Chicago are diverted into and directly affect the Des Plaines River, which is a tributary of the Upper Mississippi River system, the disposal of wastes from the Chicago area is considered in the report on that Basin.

The water of the Western Great Lakes Basin where it is not polluted is usually of excellent quality for municipal or industrial water supply requirements. It is generally clear and has comparatively little of the chlorides and sulphates which render water objectionable for domestic and industrial use.

The mineral quality of the surface waters of the interior lakes and rivers varies widely in different locations. The tributaries deliver water ranging from soft to comparatively high mineralization and hardness.

## Economic Development

The total population of the Western Great Lakes Drainage Basin in 1950 was approximately 8,969,000 exclusive of the Sanitary District of Chicago which is considered in the Summary Report on the Upper Mississippi Basin. The concentration of population over the area varies widely, being quite sparse in the rural areas and very dense in the industrial centers. There are 7 municipalities having total populations in excess of 100,000 and 31 in the range of 25,000 to 100,000.

The industry of the Basin is widely diversified. Not only are many of the resources of the Basin extensively developed but many of the resources of adjacent areas as well as those of the Basin are processed here. The various localities and industries that have achieved national or even world-wide recognition are so numerous that it is difficult to adequately describe them here.

Probably the most important mineral found in the Great Lakes area is iron ore. Iron

mining began in the area in 1854, although the industry in the Basin did not enjoy national prominence until the start of operation of the Mesabi Range in Minnesota in 1892. The importance of this mineral resource is illustrated by the fact that of the 72 million tons of iron ore produced in the United States in 1937, 61,700,000 tons were produced in the Lake Superior region.

Copper is also an important mineral resource of the area in that about one-seventh of the world's supply is mined here. The extraction of raw materials such as limestone, gas, rich brines, and oil in Michigan are other important natural resource developments. Also important is the processing of the agricultural products of this and adjacent areas. Wisconsin has been known for some time as a producer of milk products, chiefly butter and cheese. Agriculturally, fruit is an important product, particularly of Lower Michigan, and the processing and distribution of this product is economically significant. Furthermore, meat processing at Chicago and Green Bay is well known.

The manufacturing industries, however, probably bring the bulk of the wealth to the Basin. The manufacture of automobiles at Detroit, Flint, Lansing, South Bend, and Kenosha, the steel mills at Chicago and Gary, the oil refineries in the Calumet area of Indiana, and all of the various industries which support them, are well known and are an important part of the national economy.

In addition to these "big name" industries, the Basin has many more industries that are very important to the economy of the area. Recreational facilities which cater to the tourist are not normally considered an industry, but this source of income is becoming more important each year over the entire Basin and in Michigan it has already become a 700 million dollar-a-year business which entitles it to the rank of the second largest industry of that State, while in Wisconsin recreation ranks fourth as an industry. The tourist business is ranked as the second largest industry in Minnesota.

Other important industries which can only be mentioned here are furniture manufacture, pulp and paper production, saw mills, electrical equipment manufacture, chemical manufacture, and transportation.

Except for localized areas such as the Upper Michigan Peninsula and to a lesser extent the Northern portion of the Lower Michigan Peninsula, the per capita income is about the same as the U. S. average. According to unofficial but reliable sources, the approximate net effective buying income of the United States was $4,474 per family in 1949. During this same period the net effective buying power per family in the various States in the Basin was: Illinois $5,420, Michigan $4,744, Wisconsin $4,581 Minnesota $4,212, and Indiana $4,198. Within each State, however, wide variances from the average may be found.

In general, the economic level will support the needed pollution abatement facilities. The problem is not so much that the people do not have the money to pay for the facilities, but rather that they have not fully recognized the fact that pollution abatement is essential to the maintenance of their high standard of living and therefore a worthy expenditure of funds. The problem is intensified by steadily rising costs of treatment works and currently, the materials shortage situation.

## USES OF WATER RESOURCES

The uses of water resources in the Western Great Lakes Drainage Basin are many and varied. Since the use to which water is put varies in importance with the specific area, it is difficult to choose any single water use as the most dominant.

The abundance and availability of a good quality ground water has resulted in its use for public and industrial water supplies over much of the area. There are, however, a number of very important municipal water supplies obtained from surface waters which require that this use of surface water receive close attention. Some of the larger municipalities in the Basin which depend on a surface source of water supply are Chicago, Detroit, Milwaukee, Duluth, Gary, Hammond, Saginaw, Grand Rapids, and Bay City.

The industrial use of water is likewise very important in this Basin, in fact the availability of large quantities of clean water for cooling and processing, in addition to the availability of water transportation were instrumental in attracting many of the industries to this Basin. The degradation of this natural resource would seriously hamper many industrial operations.

From an area-use standpoint, the recreational use of water is of great importance. As previously mentioned, the tourist business is a major industry in at least three of the States in the Basin. The very foundation of this important industry is a water which will support fish and wildlife propagation and is suitable for other recreational uses such as swimming and boating.

The smaller streams which meander through pasture land are used extensively for stock-watering over practically the entire Basin. While this use has not been assigned an economic value, its importance can be better appreciated when one considers the value of the dairy industry to Wisconsin alone.

Navigation in the Great Lakes and to a limited extent in their tributaries is, of course, one of the keystones to the industrial development of the area. It is the connecting link on which many of the basic industries depend to bring raw materials to production centers and finally to distribute the finished product. It is significant to note that the nation, when at war, takes immediate steps to protect the connecting locks and other structures of the waterway, in order to keep this system in operation. The Chicago Sanitary and Ship Canal which connects the Great Lakes with the Illinois-Mississippi system, is also very important to national defense and peacetime commerce.

Commercial fishing at one time was a major industry in the Great Lakes. Although this industry is smaller than it has been in previous years, its economic importance is illustrated by the fact that the total United States and Canadian commercial production from the Great Lakes (including Lakes Erie and Ontario), is around 100,000,000 pounds a year. Although this catch is less than the catches of comparable sea board areas it still remains our richest source of fresh water fish.

From the foregoing, it is apparent that the water resources are used in many ways and are essential to the continued economic prosperity of the Basin.

## POLLUTION CONTRIBUTED TO WATER RESOURCES

The pollution contributed to the water resources of the Western Great Lakes Drainage Basin is shown in tables A and B. For the purpose of this report, all municipalities with sewer systems, as defined in table A, are considered a source of pollution regardless of the status of treatment or magnitude of the problem created. Reference to tables C and D will show the number of municipal and industrial waste treatment plants in the Basin. The adequacy of these treatment facilities is shown in table E.

Table A shows that there are 610 municipal sewer systems serving 6,900,000 people. The pollution load discharged to the watercourse has been established for only 57 of these systems, but it should be recognized that it is not necessary to determine the pollution load from many municipalities in order to obtain an appraisal of the problem sufficient to establish the need for treatment.

It is interesting to note that even though a number of treatment plants are represented in this group, the population equivalent to the watercourse exceeds the actual population served by 6 percent. While it is difficult to draw any conclusions from this figure, it is noteworthy because it points up the existence of strong industrial wastes in the municipal sewers. Of the 553 municipalities where the pollution load has not been determined by measurement, 181 had 1940 populations of 2,500 or over, 138 had populations between 1,000 and 2,500, 93 had populations between 500 and 1,000, and 141 had populations under 500.

Table B concerns industries which are not connected to municipal systems but which have separate outlets. Of a total of 783 known sources of industrial pollution, 311 industries discharge organic wastes. The wastes from 128 of these industries for which the pollution load discharged to the watercourse had been determined contained organic matter having an oxygen demand comparable to that of raw sewage from a population of 5,700,000 people.

In addition to the above, 494 industries discharge inorganic wastes to the streams. These wastes include mine drainage, acids, chromates, cyanides, and other inorganic substances which often cause severe pollution injury.

The tables list a number of sources of pollution for which the amount of pollution discharged to the watercourse has not been determined. Many of these sources do not require determination of this information in order to ascertain treatment needs but in certain instances where such data are needed additional field investigations will be necessary.

The pollution pattern in this Basin is not clear-cut in that no one source of pollution is outstanding. The pollution pattern is characterized by a number of acute localized problems. Some of the more serious of these problems are found in the south end of Lake Michigan, Green Bay, Saginaw Bay, and the St. Louis, Kalamazoo and Detroit Rivers.

Table A. Sources of pollution, municipal

| Municipalities* | Sources of pollution (in number of municipalities) ** | Population served by sewerage system | Amount of pollution discharged to watercourse (in terms of equivalent number of people)*** |
|---|---|---|---|
| Having data on pollution load discharged to watercourse | 57 | 598,399 | 633,862 |
| Having population data available (Data on pollution load to watercourse incomplete or not available) | 553 | 6,332,349 | Not applicable |
| Total | 610 | 6,930,748 | -- |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes all municipalities, etc. with sewer systems regardless of status of treatment or magnitude of the problem created. Reference to tables C and E is necessary to determine number of municipalities with treatment and the adequacy of such treatment.

***Includes industrial wastes discharged into municipal sewerage systems.

Table B. Sources of pollution, industrial

| Industries | Sources of pollution* (in number of plants) | Amount of pollution discharged to watercourse (in terms of equivalent number of people) |
|---|---|---|
| Producing organic wastes | 128** | 5,730,985 |
| Producing organic wastes | 183 | Undetermined |
| Producing inorganic wastes | 494 | Not applicable |
| Producing wastes of undetermined type | 8 | Undetermined |
| Total | 783*** | -- |

*Includes all industries with outlets for the discharge of waste to the watercourse regardles of the status of treatment. Reference to table D and E is necessary to determine the number of industries with treatment and the adequacy of such treatment or magnitude of the problem created.

**Includes 30 plants also producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus, **.

The international waterway which extends from Lake Huron to Lake Erie has a special pollution problem. The International Joint Commission has recently received a report from its Board of Technical Advisors which outlines the seriousness of the situation. Wastes having a population equivalent of 2,500,000 persons are discharged into these waters, 73 percent originating from American sources. Treated and untreated domestic sewage from nearly 30 American communities contribute a portion of this load, while serious industrial pollution from chemical, automotive, gas manufacturing, metal processing and coke plants is also a major factor. These waters receive daily from United States sources only, 6,120 pounds of phenols; 3,690 pounds of cyanides; 11,065 pounds of ammonium compounds; 16,280 gallons of oil and 1,702,000 pounds of suspended solids.

## DAMAGES TO WATER RESOURCES FROM WATER POLLUTION

One of the most difficult factors to evaluate completely and specifically is the damage which occurs to the water resources as the result of water pollution. Certain of the damages such as the increased cost of treatment of waters to be used as public or industrial water supplies can be accurately measured. Many damages are so varied and widespread that only rough estimates can be made. Many effects such as hazard, inconvenience, annoyance, and impairment cannot be evaluated in terms of dollars. This report will not attempt, therefore, to place any overall monetary value on the damages to the water resources due to water pollution in this Basin, but will attempt to illustrate the problem through the use of a few examples.

The problems of treatment of Lake Michigan water where the lake is used as a source of domestic water supply by the municipalities in the Chicago and Indiana areas have received attention over a period of years. Chicago's water supply is the largest one affected by pollution, but the most severe conditions are found at Whiting, Ind.

The pollution of Lake Michigan has been the subject of litigation brought before the U. S. Supreme Court. In the case of Illinois vs. Indiana, et al, filed in 1943, the defendants entered into stipulations before the master. As such stipulations were entered into, stay orders were entered as to such defendants. In November 1950 the special master recommended to the court that the case be dismissed since all stipulated work had been completed.

The water supply problem in the Detroit area is also serious. Approximately one-third of Michigan's residents depend on the St. Clair River, Lake St. Clair, and the Detroit River for their water supply. Officials responsible for pollution abatement and water treatment in this area have called attention to the increasing seriousness of the pollution of these watercourses by municipal and industrial wastes. Although there are several public water supplies affected, the largest is, of course, the Detroit public water supply with its present intake at the head of Belle Isle. At a conference on the problem with the Michigan Water Resources Commission on March 21, 1950, the General Manager, Detroit Board of Water Commissioners, reported that the Detroit raw water is subject to tastes and odors in addition to high bacterial counts. He also estimated that it would cost at least $150,000,000 to move the water intake to Lake Huron. Other communities in the area are likewise affected but involve smaller populations.

In the August 1949 report of the Board of Technical Advisors to the International Joint Commission on the Lake Huron-Lake Erie Section of the Boundary Waters, the Board found that:

> "There has been injury to health and property on both sides of the boundary. This has been manifested in the following ways:
>
> "a. Health. --A potential menace is present where waters polluted to the extent of these are used for domestic purposes. They are in such condition that they cannot be safely used as a potable supply without complete and continuously effective treatment. Much of the threat to health arises from such factors as bacterial overloading beyond the safe limits of water purification processes; variations in pollution with accompanying erratic chlorine demand; interference of certain types of pollution with disinfectants which destroy their germicidal properties; and the probability of certain infections being carried through a water treatment process, especially if there is any interruption or breakdown in a part of that process. This condition occurred in Detroit in 1926 when 45,000 cases of dysentery were reported among the water consumers.
>
> "These water are so polluted in many areas as to render them unsafe for bathing purposes. Both warning and prohibitory actions in this respect have been taken by appropriate authorities. Case histories of some typhoid fever patients in Detroit have pointed strongly to infections contracted at a Lake St. Clair beach. This damage is not only reflected in cases of typhoid fever and other reportable diseases, but it may include enteric, ear, and upper respiratory infections.
>
> "The sewage pollution present in these boundary waters must be considered as an actual and potential health hazard, whether it be through public water supplies, bathing beaches, or other vehicles. If the 1913 to 1948 trend in water pollution is permitted to continue the time will come when conditions will reach a point where it will be impossible to use these waters safely for domestic purposes.
>
> "b. Property. --Injury to property has been illustrated in the cost for extending water intakes and for water treatment, both for

municipalities and industries; in economic loss to owners of bathing beaches and other water front property; in damage to water craft; and in destruction of fish and wildlife.

"c. Industry.--There is evidence that these waters are polluted to such a degree as to affect their use in certain industries. An economic loss to the community, and to industry as well, will occur when a plant is unable to locate in an area because of inability to secure a satisfactory water supply."

The Board also stated that "The estimated cost for installation of intercepting sewers and primary treatment works for municipalities in this section is $51,000,000, of which $35,000,000 is for United States and $16,000,000 for Canadian communities"; and "The estimated cost for industrial waste treatment works is $16,000,000, of which $13,000,000 is for United States and $3,000,000 for Canadian industries."

In order to secure a satisfactory source of supply, the cities of Saginaw and Midland, Mich., abandoned the Saginaw River and constructed a pipe line approximately 78 miles long (including the branches to each city) to Lake Huron at a cost of $10,300,000.

These are but a few of the many problems of the area. It is apparent to even the casual observer that abandoned resort facilities, lowered real estate values of river sites, and fish kills are all undeniable evidence of damage.

## BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

We see from the preceding section that even in the very few cases cited that the damages due to pollution can be extensive. If through pollution prevention we avoid such damages, the benefits accrued are in the same proportion.

The intangible values of pollution prevention and abatement are recognized to be very great although quite difficult to evaluate. Good health is one of the intangible benefits recognized but difficult to measure. The importance of good community health is probably best stated by Disraeli, who stated that "The health of the people is really the foundation upon which all their happiness and all their powers as a state depend." Pollution abatement will afford protection to public health through the protection of public water supplies and general improvement to sanitary environment for greater enjoyment of living.

In the section on "Economic Development", it was indicated that recreation was Michigan's second largest and Wisconsin's fourth largest industry. In Michigan alone it is reported to be a 700 million dollar-a-year-business.

The Western Great Lakes Drainage Basin, because of its very favorable location, climate and natural beauty, has a very great potential as one of America's foremost recreational areas. With increased emphasis on greater recreational time for all workers it is easy to visualize the tourist industry growing to many times its present size.

Part of the tourist business in the Basin is concentrated in areas presently considered as economic problem areas. The claim is often heard that these areas cannot afford pollution abatement facilities. Actually they cannot afford not to abate pollution if they are to share in the recreational development.

The benefits of pollution abatement in the metropolitan areas are equally as great. In addition to the benefits to health and public water supplies previously mentioned, there is an intense desire being expressed in recent years for suitable recreational areas within and close to population areas for use by the working man and his family in his leisure time. Clean streams and lakes have a universal appeal to people and city recreational planners will probably look to the shores of their lakes and streams for future recreational development.

Much of this section has been devoted to recreation benefits since it is believed that recreational development offers one of the great promises for the future. The benefits which accrue from the other legitimate uses, however, cannot be overlooked. Many important manufacturing or processing industries require large volumes of unpolluted water for their operations. The effect of pollution on such industries would be to seriously hamper their activities, perhaps even resulting in a complete shutdown.

Likewise, the benefits derived through abatement of pollution in streams which are used for stockwatering in States recognized for outstanding production of dairy products are obvious.

## POLLUTION PREVENTION MEASURES IN EFFECT

There are 313 municipal sewage treatment plants in this Basin which serve nearly 5,700,000 people. This is approximately 82 percent of the total population connected to municipal sewers. The treatment facilities are almost equally divided into primary and secondary plants, there being 159 primary works serving over 4,000,000 people and 154 secondary works serving almost 1,700,000 people.

There has been an interest in pollution abatement in this Basin for many years and as a result many of the treatment facilities are over 10 years old. The rapid expansion of population and industry in the Basin in the past decade together with the inability to obtain materials for treatment plant expansion during seven of those years, has resulted in loadings being placed on the treatment facilities far in excess of those contemplated in the original design. We see, therefore, from table E that 109, or more than one-third of the total number of municipal treatment plants, have inadequate capacity. The operation of the existing plants is very good and only 37, or 12 percent, are reported to be unsatisfactory in this respect.

While the greatest known organic pollution in the Basin load stems from paper and allied products industries, yet 73 percent, or 56 establishments out of 77 in this group, provides some treatment for its wastes. The significance of mine drainage wastes is still largely undetermined and at present only 12 out of 368 such establishments are known to provide waste treatment. Considering industry as a whole, 36 percent of the establishments provides treatment, although 27 percent of the waste treatment plants are reported as having inadequate capacity and 11 percent of these plants are improperly operated.

Progress in pollution abatement within the Basin can be recognized by consulting tables F and H. In numbers alone new municipal sewage treatment plants have increased from three in 1946 to 13 in 1949. In 1947, three new municipal plants serving 1,000 people were built, while the 13 plants completed in 1949 serve 201,300 persons. Similarly 13 new industrial waste treatment plants were built in 1946, while 34 such plants were constructed in 1949. The 86 industrial waste treatment plants constructed during the period 1946 to 1949 were designed to treat wastes having a population equivalent of over one million.

Table H shows that some States in the Basin have employed abatement orders, 66 such orders being issued for municipalities and 43 for industries. Some States do not routinely issue orders but use this procedure only on recalcitrant cases, preferring to stimulate abatement action by working informally with the municipalities and industries concerned. One hundred and three municipalities and 89 industries are having plans prepared for waste treatment plants. State water pollution control authorities have approved plans for 60 municipal and seven industrial waste treatment works. Nineteen municipal and 19 industrial waste treatment works were under construction as of July 1, 1950.

Through the joint efforts of the Upper Mississippi River and Great Lakes Boards of Public Health Engineers, a committee, partly financed by a special Federal grant authorized under Public Law 845 (80th Congress), has been studying the standards in use in the area for the design of municipal and industrial waste treatment works.[1]

### Analysis of State Water Pollution Control Legislation

The following analysis presents briefly the salient facts regarding water pollution control legislation of the various States in the Western Great Lakes Basin. It is based on previous analyses of State legislation which were reviewed by the various States and used in the formulation of a suggested State water pollution control act which was subsequently endorsed by the Council of State Governments and recommended to the States for favorable consideration.

All five States in the Basin have specific legislation dealing with administrative handling of water pollution control functions and have provided for boards or commissions which have general water pollution abatement, prevention and control powers and duties. Under Illinois and Wisconsin statutes pollution affecting fish and game also comes under the jurisdiction of the State Department of Conservation, while in Illinois pollution resulting from oil production falls under the authority of the State Department of Mines and Minerals. The Michigan Department of Conservation has statutory authority to control pollution resulting from the oil industry.

[1] While this report was being prepared for publication the "Tentative Standards for Sewage Works," of the Upper Mississippi River Board of Public Health Engineers and Great Lakes Board of Public Health Engineers, was published in January 1951.

In four States--Illinois, Indiana, Michigan, and Minnesota--boards or commissions for water pollution control are the mixed type composed of ex-officio members representing State government and members representing affected interests; Wisconsin Stream Pollution Committee personnel are all ex-officio members of various branches of State government.

Michigan and Minnesota statutes authorize formulation of water quality standards; however, Illinois, Indiana, and Wisconsin have the same power under their right to adopt rules and regulations governing the administration and enforcement of water pollution control legislation.

Permits for construction of new sewage systems and treatment works and extensions thereof are issued in Illinois, Michigan, and Minnesota. The State Board of Health issues the permits in Michigan for construction of municipal sewers and sewage treatment plants only while the official water pollution control agency reviews the plans and issues the permits in Illinois. In Minnesota the official water pollution control agency issues the permits, but the review of plans is performed by the Department of Health. Indiana and Wisconsin do not issue permits; however, plan approval by the State Board of Health and/or the Water Pollution Control Agency is required.

All the States in the Basin have authority to issue rules and regulations relating to water pollution control. Generally this responsibility is given to the State Water Pollution Control Agency, but in Michigan, and Wisconsin, the State Health Departments also have such power, where pollution affects public health.

All States in the Basin--Illinois, Indiana, Michigan, Minnesota and Wisconsin--have authority to hold hearings and issue orders relating to pollution abatement and control. In Michigan, Minnesota and Wisconsin, such orders may also be issued by the State Board of Health. The orders relating to pollution abatement and control which may be issued in Minnesota by the State Board of Health concern only that pollution affecting water supplies for domestic use and that affecting the public health. In Michigan the Department of Health issues orders in matters affecting municipal sewage disposal where public health is involved.

Exceptions from the State water pollution control statutes do not appear in any of the Basin States except Illinois. In Illinois, pollution originating from the production of oil comes under the jurisdiction of the State Department of Mines and Minerals, and the Chicago Sanitary District is exempt from the Illinois Sanitary Water Board Act.

Table C.
Existing treatment facilities, municipal

| Degree of treatment provided | Number | | Population served |
|---|---|---|---|
| | Municipalities* | Plants | |
| Primary | 203 | 159 | 4,028,913 |
| Secondary | 168 | 154 | 1,656,210 |
| No treatment | 239 | Not applicable | 1,245,625 |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D. Existing treatment facilities, industrial*

| Type industry | Number of plants | Number of industrial plants having: | | |
|---|---|---|---|---|
| | | Treatment facilities | No treatment facilities | Undetermined facilities |
| Food and kindred products..... | 183 | 108 | 73 | 2 |
| Texile mill products..... | 3 | 0 | 3 | 0 |
| Lumber and wood products..... | 4 | 2 | 2 | 0 |
| Paper and allied products..... | 77 | 56 | 21 | 0 |
| Chemical and allied products..... | 56 | 37 | 18 | 1 |
| Products of petroleum and coal..... | 9 | 7 | 2 | 0 |
| Rubber products..... | 2 | 1 | 1 | 0 |
| Leather and leather products..... | 8 | 6 | 2 | 0 |
| Primary metal industries... | 12 | 5 | 6 | 1 |
| Fabricated metal products..... | 37 | 27 | 10 | 0 |
| Miscellaneous..... | 9 | 6 | 3 | 0 |
| Oil production industry.... | 15 | 14 | 1 | 0 |
| Mine drainage..... | 368 | 12 | 33 | 323 |
| Total..... | 783 | 281 | 175 | 327 |

*Industries having separate outlets and discharging wastes directly to watercourse.

Table E. Adequacy of existing treatment facilities

| Existing treatment facilities | Number | Adequacy with relation to: | | | | | |
|---|---|---|---|---|---|---|---|
| | | Capacity | | | Operation | | |
| | | Satis-factory | Unsatis-factory | Unde-rmined | Satis-factory | Unsatis-factory | Unde-termined |
| Municipal | 313 | 192 | 109 | 12 | 245 | 37 | 31 |
| Industrial | 281 | 168 | 77 | 36 | 209 | 31 | 41 |

Table F. Progress in pollution abatement

| Year | Municipal | | Industrial | |
|---|---|---|---|---|
| | Plants completed | Design population | Plants completed | Amount of waste treated (in terms of equivalent number of people) |
| 1946 | 3 | Undetermined | 13 | 420,500 |
| 1947 | 3 | 1,000 | 8 | 344,350 |
| 1948 | 11 | 19,901 | 31 | 150,650 |
| 1949 | 13 | 201,300 | 34 | 132,900 |

## POLLUTION PREVENTION MEASURES REQUIRED

Municipalities, having a total population of 1,200,000 require 187 new sewage treatment plants. Enlargements or additions are required for 84 municipal waste treatment plants serving 4,500,000 persons, and 23 existing obsolete works serving 42,000 people must be replaced. The estimated cost of this construction known to be required is approximately $95,000,000.

Attention is invited to the fact that the above cost data are necessarily a rough estimate. Where figures were available from reports they were used and adjusted to an approximate 1950 cost estimate; where none were available cost estimates were made based on the method advanced by Professor C. J. Velz in the October 14, 1948 issue of "Engineering News-Record." A cost index of 246 for July 1950, was used and all estimates were based on 1940 populations.

Recognizing that these expenditures will take place over a number of years, the estimated costs will be increased due to added factors. These include annual obsolescence and rehabilitation requirements, needs of communities installing new sewer systems, normal population increases and industrial expansion as well as allowance for presently undetermined needs.

One hundred and four industrial establishments which now discharge untreated wastes to the watercourses require new waste treatment plants, while 58 additional industries possess waste treatment facilities, which require enlargements or additions. Nineteen industrial waste treatment works are obsolete and must be replaced. The cost of the industrial waste treatment works known to be needed is estimated to be equal to or greater than the cost of the needed municipal facilities.

The estimated cost of industrial facilities was quite difficult to obtain, since industry itself is quite reluctant to release figures of this nature, in addition to the fact that waste treatment is often closely related to by-product recovery and process changes which cannot always be charged to treatment costs.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

| Population group | New plant | Enlargement or additions to existing plant | Replace existing plant | Undetermined |
|---|---|---|---|---|
| Less than 500..... | 29 | 8 | 5 | 9 |
| 500 to 1,000. | 31 | 5 | 9 | 6 |
| 1,000 to 2,500..... | 64 | 21 | 4 | 11 |
| Over 2,500.. | 63 | 50 | 5 | 4 |
| Total..... | 187 | 84 | 23 | 30 |

Among the communities reported as requiring new municipal waste treatment plants are five municipalities, serving 10,750 persons, which in all probability will connect to nearby municipal sewer systems. Similarly, those industries reported as requiring new industrial waste treatment works include at least five industries which probably will discharge their wastes into nearby city sewers.

The pollution control laws of the States in this Basin are good workable laws, and it is not anticipated that major additional enforcement legislation will be needed in the near future. There is a need, however, for improved legislation to avoid some of the financial barriers now interfering with the progress of planned work to the construction phase.

Table G. Requirements for municipal and industrial waste treatment plants*

| Requirements[1] | Municipal | | Industrial |
|---|---|---|---|
| | Number | Population served by facilities | Number |
| New plant | 187 | 1,204,281 | 104 |
| Enlargement or additions to existing plant | 84 | 4,548,657 | 58 |
| Replace existing plant | 23[2] | 42,832 | 19 |
| No project required[3] | 226 | 902,113 | 187 |
| Undetermined | 30 | 232,865 | 415 |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

[1]For individual project needs refer to table I contained in each of the sub-basin discussions which follow part 1 of this report.

[2]Includes one municipality which now has three waste treatment plants that are to be replaced by one treatment plant.

[3]Includes 34 municipal and 19 industrial minor sources of pollution not included in table E for which existing disposal methods are considered satisfactory for present stream conditions.

Table H. Status of treatment works project to abate pollution, July 1, 1950

| Status of project | Number | |
|---|---|---|
| | Municipal | Industrial |
| No formal action | 36 | 13 |
| Abatement ordered | 66 | 43 |
| Plans under preparation | 103 | 89 |
| Final plans approved | 60 | 7 |
| Construction awaiting financing | 13 | 2 |
| Under construction | 19 | 19 |
| Status undetermined | 93 | 466 |

SUB-BASIN INDEX

1. Lake Superior
2. Lake Michigan - Western Shore
3. Lake Michigan - Eastern Shore
4. Lake Huron
5. Detroit Area - Lake Huron To Lake Erie

NUMBER OF MUNICIPAL SOURCES

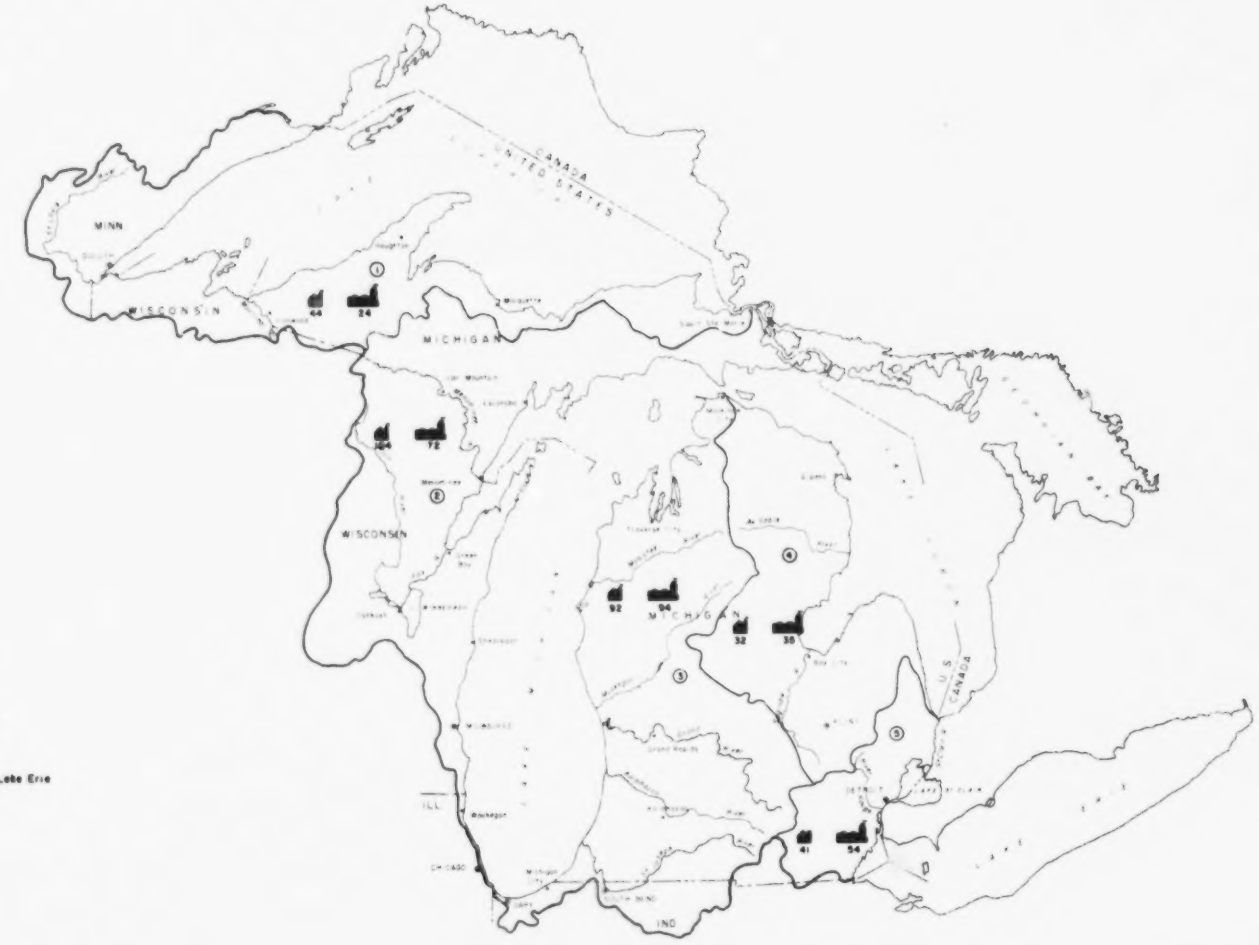
NUMBER OF INDUSTRIAL SOURCES

SCALE OF MILES
40 20 0 40 80 120 160

WESTERN GREAT LAKES
DRAINAGE BASINS

# SOURCES OF POLLUTION

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP No. 1




**SUB-BASIN INDEX**

1. Lake Superior
2. Lake Michigan-Western Shore
3. Lake Michigan-Eastern Shore
4. Lake Huron
5. Detroit Area-Lake Huron To Lake Erie

NUMBER OF EXISTING MUNICIPAL TREATMENT WORKS

NUMBER OF EXISTING INDUSTRIAL TREATMENT WORKS

SCALE OF MILES
40 20 0 40 80 120 160

WESTERN GREAT LAKES
DRAINAGE BASINS

# EXISTING TREATMENT WORKS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP No 2

SUB-BASIN INDEX

1. Lake Superior Basin
2. Lake Michigan - Western Shore Basin
3. Lake Michigan - Eastern Shore Basin
4. Lake Huron Basin
5. Detroit Area - Lake Huron To Lake Erie Basin

NUMBER OF MUNICIPAL PROJECT REQUIRED

NUMBER OF MUNICIPALITIES WITH PROJECT REQUIREMENTS UNDETERMINED

NUMBER OF INDUSTRIAL PROJECTS REQUIRED

NUMBER OF INDUSTRIES WITH PROJECT REQUIREMENTS UNDETERMINED

SCALE OF MILES
40 20 0 40 80 120 160

WESTERN GREAT LAKES
DRAINAGE BASINS

# PROJECTS REQUIRED

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP No 3

WESTERN GREAT LAKES
DRAINAGE BASINS

# EXISTING PRIMARY WATER USES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP No 4

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## SUB-BASIN REPORTS

### LAKE SUPERIOR SUB-BASIN

This sub-basin consists of the American section of the Lake Superior drainage area. The drainage area lies in an east-west direction extending 430 miles along this axis and 130 miles in a north-south direction, the latter distance being measured across the lake. The area comprises a narrow strip of land along the south and west shore of the lake. Lake Superior is the largest and deepest of the Great Lakes; depths of nearly 1,200 feet have been sounded.

The drainage extends over portions of Minnesota, Wisconsin and Michigan, having a total area of 16,652 square miles with 37 percent in Minnesota, 18 percent in Wisconsin, and 45 percent in Michigan. The shoreline is often steep in many places which together with the cold water tend to limit bathing. Portions of the land area are nearly 1,400 feet above Lake Superior or more than 2,000 feet above sea level.

The principal rivers tributary to the lake are the St. Louis, Montreal, Ontonagon and the Sturgeon. A number of small streams also empty into the lake but are of little significance. The sub-basin has a very long shoreline and the close proximity of the lake has a definite effect on climatic conditions in the sub-basin.

The land area was entirely covered during the great glacier period which created a flat topography with numerous small lakes. The soils are composed of a complex mantle of glacial detritus, largely sands, being highly permeable and having considerable ground water storage. Valuable forest stands cover the land area of the sub-basin.

The climate of the area is a modified marine type most of the year being greatly tempered by the lake area when wind movements occur from the water. The average January temperature varies from 6° F. to 16° F., while the corresponding average July temperatures range from 60°F. to 66° F. The growing season extends from 80 days to 140 days, decreasing with the distance from the lake. The average annual precipitation is between 26 inches and 32 inches with about 55 percent occurring during the growing season.

The 1950 population was 366,415 and is centered in several municipalities within the sub-basin. Rural areas are sparsely settled, some counties having fewer than 11 persons per square mile. The larger cities in the sub-basin include Duluth, Superior, Two Harbors, Ashland, Marquette and Ironwood. These cities sprang up primarily as a result of extensive mining operations in the area.

Mining, navigation, and lumbering with its by-products of paper and wood constitute the more important industries of the area. The importance of navigation on Lake Superior cannot be over-emphasized. During 1947 over 22,000 vessels carrying more than 83,000,000 tons of cargo, passed through the locks at Sault Ste. Marie. Some of the largest copper and iron mines in the United States are found here. Agriculture is only of minor importance in the area.

Eighty sewered municipalities serving 319,400 people are located in this sub-basin. Of this number, 23 municipalities provide secondary treatment serving 45,000 people and 20 municipalities provide primary treatment serving 113,000 people. Of the 37 municipalities which do not provide treatment, two have populations less than 500, nine have populations between 500 and 1,000, 11 have populations between 1,000 and 2,500, and 15 have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by 383 industries, 24 of which have provided treatment for their wastes. It should be noted that 357 of the total are mines and at this time it is thought that many are insignificant from a pollution standpoint.

Table $E_1$ is an analysis of the adequacy of existing treatment facilities. This table indicates that 14 of the municipal and nine of the industrial waste treatment plants have unsatisfactory capacity and that the operation should be improved at 10 municipal and six industrial waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in Table $G_1$. This shows that 29 new municipal plants are needed and that 12 existing plants need enlargements or additions. Two plants are reported to need replacement. It is also noted that 13 new industrial waste treatment plants are needed while five are in need of enlargement or additions. Four existing industrial waste treatment plants need to be replaced.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

44/76
LIBRARY
SANITARY ENGINEERING CENTER
CINCINNATI, OHIO

| Population group | New plant | Enlargement or additions to existing plant | Replace existing plant | Undetermined |
|---|---|---|---|---|
| Less than 500..... | 2 | 5 | 1 | 1 |
| 500 to 1,000 | 5 | 1 | 0 | 4 |
| 1,000 to 2,500..... | 7 | 3 | 0 | 4 |
| Over 2,500. | 15 | 3 | 1 | 1 |
| Total..... | 29 | 12 | 2 | 10 |

Progress in pollution abatement, as evidenced by construction of waste treatment works, has not been rapid in this sub-basin. Table $E_1$ shows that during 1946-49 only three municipal and no industrial waste treatment plants were constructed. Undoubtedly much of this is due to the difficulties of doing any construction work during at least two years of this period, largely because of material shortages. As shown in table $H_1$, a number of municipal and industrial waste treatment plant projects are in various stages of planning. Final completion of these plants will depend largely on whether materials will be available and whether construction organizations can be retained.

Recreational water use probably is one of the most important in the sub-basin. Others of considerable importance are municipal and industrial water supply, navigation, and some stockwatering. Duluth and Superior together have one of the great ports of the Great Lakes; as the upper terminus for shipping in that waterway the port handles, in addition to iron ore, large tonnages of grain, coal, and other bulk freight as well as packaged freight. In 1947 the total tonnage handled by the port was 64,390,000 tons. Commercial fishing is carried on in parts of Lake Superior and has importance in this sub-basin .

Game and commercial fishing, bathing, and livestock watering have all been damaged on the St. Louis River, mainly by industrial wastes. Municipal and industrial wastes have damaged recreational water use in the St. Mary's River; municipal water supply has been impaired at Marquette by industrial and municipal wastes, and recreational uses have been impaired at Munising by municipal and industrial wastes. Game fishing has been harmed by raw sewage on the Ontonagon and Tahquamenon Rivers and by municipal and industrial wastes on the Little Black and Carp Rivers. Numerous localized pollution occurs in the vicinity of a number of municipalities.

While other and less significant pollution problems exist in the sub-basin, only the more pressing have been given attention by the State water pollution control agencies because of staff limitations.

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (tables B and I), the population equivalent of the waste was used when known.

Table $A_1$. Sources of pollution, municipal

| Municipalities* | Sources of pollution (in number of municipalities)** | Population served by sewerage system | Amount of pollution discharged to watercourse (in terms of equivalent number of people)*** |
|---|---|---|---|
| Having data on pollution load discharged to watercourse | 1 | 700 | 3,170 |
| Having population data available (Data on pollution load to watercourse incomplete or not available) | 79 | 318,702 | Not applicable |
| Total | 80 | 319,402 | -- |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourses.

**Includes all municipalities, etc. with sewer systems regardless of status of treatment or magnitude of the problem created. Reference to tables C and E is necessary to determine number of municipalities with treatment and the adequacy of such treatment.

***Includes industrial wastes discharged into municipal sewerage systems.

Table $B_1$. Sources of pollution, industrial

| Industries | Sources of pollution* (in number of plants) | Amount of pollution discharged to watercourse (in terms of equivalent number of people) |
|---|---|---|
| Producing organic wastes | 11** | 594,095 |
| Producing organic wastes | 12 | Undetermined |
| Producing inorganic wastes | 363 | Not applicable |
| Producing wastes of undetermined type | 0 | Undetermined |
| Total | 383*** | -- |

*Includes all industries with outlets for the discharge of waste to the watercourse regardless of the status of treatment or magnitude of the problem created. Reference to tables D and E is necessary to determine the number of industries with treatment and the adequacy of such treatment.

**Includes 3 plants also producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus,**.

Table $C_1$.
Existing treatment facilities, municipal

| Degree of treatment provided | Number | | Population served |
|---|---|---|---|
| | Municipalities* | Plants | |
| Primary | 20 | 20 | 112,976 |
| Secondary | 23 | 24 | 44,915 |
| No treatment | 37 | -- | 161,511 |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table $D_1$. Existing treatment facilities, industrial*

| Type industry | Number of plants | Number of industrial plants having: | | |
|---|---|---|---|---|
| | | Treatment facilities | No treatment facilities | Undetermined facilities |
| Food and kindred products..... | 14 | 7 | 5 | 2 |
| Lumber and wood products..... | 1 | 0 | 1 | 0 |
| Paper and allied products..... | 5 | 5 | 0 | 0 |
| Chemical and allied products..... | 1 | 0 | 1 | 0 |
| Leather and leather products..... | 1 | 1 | 0 | 0 |
| Primary metal industries... | 4 | -- | 3 | 1 |
| Mine drainage..... | 357 | 11 | 23 | 323 |
| Total..... | 383 | 24 | 33 | 326 |

*Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_1$. Adequacy of existing treatment facilities

| Existing treatment facilities | Number | Adequacy with relation to: | | | | | |
|---|---|---|---|---|---|---|---|
| | | Capacity | | | Operation | | |
| | | Satisfactory | Unsatisfactory | Undetermined | Satisfactory | Unsatisfactory | Undetermined |
| Municipal | 44 | 27 | 14 | 3 | 19 | 10 | 15 |
| Industrial | 24 | 6 | 9 | 9 | 11 | 6 | 7 |

Table $F_1$. Progress in pollution abatement

| Year | Municipal | | Industrial | |
|---|---|---|---|---|
| | Plants completed | Design population | Plants completed | Amount of waste treated (in terms of equivalent number of people) |
| 1946 | 1 | Undetermined | None | -- |
| 1947 | 1 | Undetermined | None | -- |
| 1948 | None | -- | None | -- |
| 1949 | 1 | Undetermined | None | -- |

Table $G_1$. Requirements for municipal and industrial waste treatment plants*

| Requirements | Municipal | | Industrial |
|---|---|---|---|
| | Number | Population served by facilities | Number |
| New plant | 29 | 151,743 | 13 |
| Enlargement or additions to existing plant | 12 | 28,490 | 5 |
| Replace existing plant | 2 | 4,059 | 4 |
| No project required** | 28 | 24,565 | 6 |
| Undetermined | 10 | 110,545 | 355 |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**Includes one minor municipal source of pollution not included in table $E_1$ for which existing disposal methods are considered satisfactory for present stream conditions.

Table $H_1$. Status of treatment works project to abate pollution, July 1, 1950

| Status of project | Number | |
|---|---|---|
| | Municipal | Industrial |
| No formal action | 7 | 2 |
| Abatement ordered | 7 | 0 |
| Plans under preparation | 13 | 10 |
| Final plans approved | 9 | 1 |
| Construction awaiting financing | 0 | 0 |
| Under construction | 0 | 0 |
| Status undetermined | 24 | 364 |

Table $I_1$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

| Name | Population served** | Project requirements | Remarks |
|---|---|---|---|
| MICHIGAN | | | |
| Baltic: | | | |
| Stella Cheese Co. | 915 | Replacement | Planning initiated |
| Bergland Township | 320 | New plant | -- |
| Ewen | 700 | New plant | Planning initiated |
| Ewen Farmers Co-op Creamery | 2,400 | New plant | -- |
| Hancock | 5,554 | New plant | Planning initiated |
| Houghton | 3,693 | New plant | Planning initiated |
| Michigan College of Mining and Technology | 1,600 | New plant | Planning initiated |
| Ironwood | 13,369 | New plant | Plans approved; under order |
| Davis-Geneva Mines | -- | New plant | Inorganic waste; planning initiated |
| Newport Bonnie Mines | -- | New plant | Inorganic waste; planning initiated |
| Ishpeming | 9,491 | New plant | Planning initiated |
| L'Anse | 2,564 | New plant | Plans approved |
| Marquette | 15,928 | New plant | Plans approved; under order |
| Cliffs Dow Chemical Co. | Not applicable | New plant | -- |
| Marquette Branch Prison | 900 | New plant | Plans approved for connection to Marquette in lieu of new plant |
| Munising | 4,403 | New plant | Plans approved |
| Munising Paper Co. | 31,900 | Enlargement | Planning initiated |
| Newberry State Hospital | 4,300 | New plant | Planning initiated |
| Ontonagon | 2,290 | New plant | Planning initiated |
| Sault Ste. Marie | 15,847 | New plant | Plans approved; under order |
| Northwestern Leather Co. | PEU *** | Replacement | Plans approved |
| Wakefield | 3,591 | New plant | Plans approved |
| MINNESOTA | | | |
| Biwabik | 1,200 | New plant | Planning initiated |
| Buhl: | | | |
| Grant Mine | -- | Enlargement | Inorganic mine drainage; planning initiated |
| Carlton | 630 | New plant | -- |
| Cloquet | 6,600 | New plant | -- |
| Northwest Paper Co. | 393,000 | Enlargement | Planning initiated |
| Wood Conversion Co. | 161,000 | Enlargement | Planning initiated |
| Chisholm | 6,700 | New plant | -- |
| Fraser: | | | |
| Elbern Mine | -- | New plant | Inorganic mine drainage; planning initiated |
| Fraser Mine | -- | New plant | Inorganic mine drainage; planning initiated |
| Sherman Mine | -- | New plant | Inorganic mine drainage; planning initiated |
| Floodwood | 510 | New plant | -- |
| Agnew Mine | -- | New plant | Inorganic mine drainage |
| S. Agnew Mine | -- | New plant | Inorganic mine drainage |
| Meadowlands: | | | |
| Meadowlands Cheese Factory | PEU*** | Replacement | -- |
| Two Harbors | 4,046 | New plant | Planning initiated |
| Virginia | 11,000 | Enlargement | Planning initiated |

See footnotes at end of table.

Table I$_1$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

| Name | Population served** | Project requirements | Remarks |
|---|---|---|---|
| WISCONSIN | | | |
| Ashland | 8,000 | New plant | Planning initiated; under order |
| Consolidated Products Co. | 756 | New plant | -- |
| Pioneer Creamery | PEU*** | New plant | -- |
| Barksdale: | | | |
| DuPont Munitions | 593 | New plant | -- |
| Bayfield | 800 | New plant | Planning initiated; under order |
| Hurley | 2,500 | New plant | -- |
| Mellen | 1,400 | New plant | Plans approved |
| Montreal | 1,500 | New plant | -- |
| Poplar: | | | |
| Poplar Canning Co. | PEU*** | New plant | -- |
| Superior | 32,500 | New plant | Under order; plans approved |
| Washburn | 1,900 | New plant | Under order; planning initiated |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**Population equivalent for industry.

***PEU is abbreviation for Population Equivalent Undetermined.

## LAKE MICHIGAN (WESTERN SHORE) SUB-BASIN

This sub-basin contains only the western portion of the drainage to Lake Michigan and extends from the Straits of Mackinac to the northern limits of the Sanitary District of Chicago. The metropolitan Chicago area, since it drains to the Mississippi through the sanitary and ship canal, is considered in the summary report on the Upper Mississippi River Basin.

The sub-basin is roughly trapezoidal in shape, having a maximum north-south length along the lake shore of 380 miles and a maximum width of 120 miles in the vicinity of Green Bay, Wis. There are 24,000 square miles in the sub-basin, with 62 percent in Wisconsin, nearly 38 percent in the northern peninsula of Michigan and less than one percent in Illinois.

The principal tributaries to the lake in this sub-basin are the Manistique, Escanaba, Menominee, Fox, and the Milwaukee Rivers. Numerous smaller rivers and creeks are also tributary to the lake along the entire length of the western shore.

The topography and soils of the area have been generally determined by the various glaciations to which these lands have been subjected so that much of the area is rolling or hilly. The climate of the sub-basin is fairly moderate but somewhat cool. The average January temperature ranges from 12°F. at the northern edge of the sub-basin to 22°F. at the southern edge of the sub-basin, while the corresponding average July temperatures are 64°F. and 72°F. The growing season varies from 100 days in the north to 170 days in the south. The average annual precipitation is between 28 and 32 inches with 60 percent to 75 percent occurring during the growing season.

The population of the sub-basin in 1950 was 2,063,477 and is largely concentrated in the Wisconsin and Illinois sections of the sub-basin. The largest population concentration in the sub-basin is found around Milwaukee. This concentration has a maximum of 3,200 persons per square mile in Milwaukee County and diminishes slightly between Milwaukee and Chicago. The remainder of the sub-basin has several smaller but heavily populated areas. Major cities in the sub-basin are Milwaukee, Green Bay, Sault Ste. Marie, Racine and Kenosha.

Industry is highly diversified in this sub-basin. In the northern part of the sub-basin, logging, sawmills, and allied wood products predominate. The Menominee River drainage area has some mining and food processing industries, while in the lower portion of the Fox River drainage area the outstanding industries are paper manufacture and canning. In the southern part of the sub-basin just south of Milwaukee machinery and automobile production predominate. While agriculture is not an outstanding industry, it is nevertheless an important and vital part of the economy.

One hundred and fifty-three sewered municipalities serving 1,450,000 people are located in this sub-basin. Of this number 67 municipalities provide secondary treatment serving 868,700 people and 56 municipalities provide primary treatment serving 505,700 people. Of the 30 municipalities which do not provide treatment seven have populations less than 500, five have populations between 500 and 1,000, seven have populations between 1,000 and 2,500 and 11 have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by 120 industries, 72 of which have provided treatment for their wastes.

Table $E_2$ is an analysis of the adequacy of existing treatment facilities. This table indicates that 19 of the municipal and 13 of the industrial waste treatment plants have unsatisfactory capacity and that the operation should be improved at 14 municipal and four industrial waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in Table $G_2$. This shows that 28 new municipal plants are needed and that 11 existing plants need enlargement or additions. Six plants are reported to need replacement. It is also noted that 33 new industrial waste treatment plants are needed while nine are in need of enlargement or additions. It is reported that four existing industrial waste treatment plants need to be replaced.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

| Population group | New plant | Enlargement or additions to existing plant | Replace existing plant | Undetermined |
|---|---|---|---|---|
| Less than 500 ..... | 6 | 3 | 0 | 0 |
| 500 to 1,000 | 5 | 2 | 6 | 0 |
| 1,000 to 2,500 .... | 7 | 1 | 0 | 2 |
| Over 2,500. | 10 | 5 | 0 | 2 |
| Total ..... | 28 | 11 | 6 | 4 |

Progress in pollution abatement can be observed in studying table $F_2$. Construction of municipal sewage treatment plants has increased from 1946, when none were built, to 1949 when four plants serving 5,800 persons were constructed. Construction of industrial waste treatment works has averaged five plants per year during the 1946-1949 period. Table $H_2$, dated July 1, 1950, shows orders for abatement of pollution have been issued to seven municipalities and 23 industries, while plans for ten municipal and 16 industrial waste treatment works are under preparation. Final plans have been approved for nine municipal plants, while seven municipal and six industrial waste treatment works were under construction as of July 1, 1950.

Nearly all the water uses are present in this sub-basin. In the northern part of the sub-basin, the recreational uses such as fishing, boating, swimming, and wildlife propagation predominate, and in the southern area public and industrial water supplies and stockwatering are the principal uses. Navigation, however, is also an important water use The port of Milwaukee, for instance, is an important car ferry terminal, a center for the distribution of coal, and a shipping point for machinery, grain and animal products; Escanaba is an important shipping point for iron ore; and Green Bay is an important coal distribution center. There are numerous other lesser ports on the lake and some of the major streams. Other uses of the waters of the sub-basin include commercial fishing and natural ice production.

Pollution in the Menominee River portion of the sub-basin is particularly severe because of domestic wastes from several municipalities and also due to mining, paper and sugar refinery wastes.

Bathing and game fishing are damaged in several places on the Menominee, while industrial water supply has been affected by strong industrial wastes reaching the Oconto River. It is estimated that the organic wastes discharged to the Oconto River in the Oconto-Oconto Falls section have a population equivalent of over 180,000, 90 percent of which is contributed by a paper company at Oconto Falls.

The lower Fox River has an extremely heavy organic industrial pollution load having a population equivalent of over 1,800,000. Municipal wastes bring the total population equivalent to over 2,000,000. Death and decomposition of excessive algal growths also contribute serious pollution to the Fox below Lake Winnebago. The pollution of the Fox River in this area has damaged domestic water supply. A wide variety of industries is located in this sub-basin.

Other pollution problems less serious in nature also exist in the sub-basin and have received the attention of the State water pollution control agencies.

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (tables B and I), the population equivalent of the waste was used when known.

Table $A_2$. Sources of pollution, municipal

| Municipalities* | Sources of pollution (in number of municipalities)** | Population served by sewerage system | Amount of pollution discharged to watercourse (in terms of equivalent number of people)*** |
|---|---|---|---|
| Having data on pollution load discharged to watercourse | 25 | 221,589 | 190,198 |
| Having population data available (Data on pollution load to watercourse incomplete or not available) | 128 | 1,227,777 | Not applicable |
| Total | 153 | 1,449,366 | -- |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes all municipalities, etc. with sewer systems regardless of status of treatment or magnitude of the problem created. Reference to table C and E is necessary to determine number of municipalities with treatment and the adequacy of such treatment.

***Includes industrial wastes discharged into municipal sewerage systems.

Table $B_2$. Sources of pollution, industrial

| Industries | Sources of pollution* (in number of plants) | Amount of pollution discharged to watercourse (in terms of equivalent number of people) |
|---|---|---|
| Producing organic wastes | 32** | 2,971,143 |
| Producing organic wastes | 59 | Undetermined |
| Producing inorganic wastes | 28 | Not applicable |
| Producing wastes of undetermined type | 8 | Undetermined |
| Total | 120*** | -- |

* Includes all industries with outlets for the discharge of waste to watercourse regardless of the status of treatment or magnitude of the problem created. Reference to tables D and E is necessary to determine the number of industries with treatment and the adequacy of such treatment.

** Includes 7 plants also producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus,**.

Table $C_2$.
Existing treatment facilities, municipal

| Degree of treatment provided | Number | | Population served |
|---|---|---|---|
| | Municipalities* | Plants | |
| Primary | 56 | 51 | 505,663 |
| Secondary | 67 | 53 | 868,696 |
| No treatment | 30 | -- | 75,007 |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table $D_2$. Existing treatment facilities, industrial*

| Type industry | Number of plants | Number of industrial plants having: | | |
|---|---|---|---|---|
| | | Treatment facilities | No treatment facilities | Undetermined facilities |
| Food and kindred products..... | 62 | 40 | 22 | 0 |
| Lumber and wood products..... | 3 | 2 | 1 | 0 |
| Paper and allied products..... | 32 | 22 | 10 | 0 |
| Chemical and allied products..... | 1 | 1 | 0 | 0 |
| Products of petroleum and coal..... | 0 | 0 | 0 | 0 |
| Leather and leather products..... | 2 | 1 | 1 | 0 |
| Primary metal industries.. | 2 | 0 | 2 | 0 |
| Fabricated metal products..... | 4 | 3 | 1 | 0 |
| Miscellaneous..... | 3 | 2 | 1 | 0 |
| Mine drainage..... | 11 | 1 | 10 | 0 |
| Total..... | 120 | 72 | 48 | 0 |

*Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_2$. Adequacy of existing treatment facilities

| Existing treatment facilities | Number | Adequacy with relation to: | | | | | |
|---|---|---|---|---|---|---|---|
| | | Capacity | | | Operation | | |
| | | Satisfactory | Unsatisfactory | Undetermined | Satisfactory | Unsatisfactory | Undetermined |
| Municipal | 104 | 82 | 19 | 3 | 83 | 14 | 7 |
| Industrial | 72 | 57 | 13 | 2 | 66 | 4 | 2 |

Table $F_2$. Progress in pollution abatement

| Year | Municipal | | Industrial | |
|---|---|---|---|---|
| | Plants completed | Design population | Plants completed | Amount of waste treated (in terms of equivalent number of people) |
| 1946 | None | -- | 5 | 84,000 |
| 1947 | 1 | Undetermined | 4 | 124,350 |
| 1948 | 3 | 6,200 | 5 | 128,400 |
| 1949 | 4 | 5,800 | 6 | 96,900 |

Table $G_2$. Requirements for municipal and industrial waste treatment plants*

| Requirements | Municipal | | Industrial |
|---|---|---|---|
| | Number | Population served by facilities | Number |
| New plant | 28 | 72,367 | 33 |
| Enlargement or additions to existing plant | 11 | 814,700 | 9 |
| Replace existing plant | 6** | 4,915 | 4 |
| No project required*** | 83 | 546,244 | 60 |
| Undetermined | 4 | 11,140 | 14 |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**Includes one municipality which now has three waste treatment plants that are to be replaced by one treatment plant.

***Includes one municipal and three industrial minor sources of pollution not included in table $E_2$ for which existing disposal methods are considered satisfactory for present stream conditions.

Table $H_2$. Status of treatment works project to abate pollution, July 1, 1950

| Status of project | Number | |
|---|---|---|
| | Municipal | Industrial |
| No formal action | 2 | 0 |
| Abatement ordered | 7 | 23 |
| Plans under preparation | 10 | 16 |
| Final plans approved | 9 | 0 |
| Construction awaiting financing | 0 | 0 |
| Under construction | 7 | 6 |
| Status undetermined | 21 | 38 |

Table $I_2$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

| Name | Population served** | Project requirements | Remarks |
|---|---|---|---|
| ILLINOIS | | | |
| Arden Shores Camp..... | 250 | Enlargement | -- |
| Chemical industrial plants: | | | |
| ***1 Plant..... | -- | Replacement | Both organic and inorganic wastes. Planning initiated |
| Metal fabricating plants: | | | |
| ***1 Plant..... | -- | Enlargement | Undetermined whether organic or inorganic waste. Planning initiated. |
| Miscellaneous manufacturing plants: | | | |
| ***1 Plant..... | -- | Enlargement | Inorganic waste. Planning initiated |
| MICHIGAN | | | |
| Alpha..... | 500 | Enlargement | Plans approved |
| Caspian..... | 1,800 | Enlargement | -- |
| Iron Mountain..... | 11,080 | New plant | Plans approved |
| Iron River..... | 4,500 | New plant | Planning initiated |
| Kingsford..... | 5,770 | New plant | Plans approved |
| Mackinac Island..... | 510 | New plant | -- |
| Manistique..... | 5,400 | New plant | Planning initiated |
| Menominee: | | | |
| Superior Sugar Co..... | 92,000 | Enlargement | Planning initiated; under order |
| Negaunee..... | 6,810 | New plant | Planning initiated |
| Norway..... | 3,730 | New plant | -- |
| Rapid River: | | | |
| Rapid River Co-op Creamery... | PEU**** | New plant | -- |
| Stambaugh..... | 2,080 | New plant | Planning initiated |
| WISCONSIN | | | |
| Appleton: | | | |
| Appleton Juvenile Furniture Co..... | PEU**** | New plant | -- |
| Consolidated Water Power & Paper Co..... | 365,800 | New plant | Under order, planning initiated |
| Belgium: | | | |
| Krier Preserve Co. (Canning)..... | PEU**** | Replacement | -- |
| Berlin..... | 3,800 | New plant | Plans approved |
| Stokely Foods, Inc..... | PEU**** | New plant | -- |
| Brillion..... | 900 | Replacement | Planning initiated |
| Coleman: | | | |
| Coleman Canning Co..... | PEU**** | New plant | -- |
| Denmark..... | 800 | Replacement | -- |
| De Pere: | | | |
| U. S. Paper Corp..... | 1,680 | Enlargement | Under order, planning initiated |
| Dundas: | | | |
| Cambria Canning Corp..... | PEU**** | New plant | -- |
| Eden: | | | |
| Mammoth Spring Canning Co... | PEU**** | Enlargement | -- |
| Florence..... | 1,350 | New plant | -- |
| Forestville Sanitary District. | 270 | New plant | Planning initiated |
| Francis Creek Sanitary District..... | 100 | Enlargement | -- |
| Fredonia: | | | |
| Fredonia Canned Foods, Inc.. | PEU**** | Replacement | -- |

See footnotes at end of table.

Table $I_2$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

| Name | Population served** | Project requirements | Remarks |
|---|---|---|---|
| WISCONSIN--Continued | | | |
| Glenbeulah: | | | |
| Glenbeulah Canning Co..... | PEU**** | Enlargement | -- |
| Green Bay..... | 50,000 | Enlargement | Under order, planning initiated |
| Ft. Howard Paper Co..... | 16,680 | Enlargement | -- |
| Green Bay Pulp & Paper Co... | 75,000 | New plant | Under order |
| Hoberg Paper Mills (Pulp)... | 369,480 | New plant | Under order, planning initiated |
| Northern Paper Mills..... | 607,440 | New plant | Under order, planning initiated |
| Hilbert: | | | |
| Valders Canning Co..... | PEU**** | New plant | -- |
| Hortonville..... | 968 | New plant | Construction authorized |
| Fox Valley Canning Co..... | PEU**** | New plant | Construction authorized |
| Kaukana: | | | |
| Thitmany Pulp & Paper Co. (Pulp)..... | 57,120 | New plant | Under order, construction authorized |
| Keshena: | | | |
| Indian Reservation..... | 250 | New plant | Construction authorized |
| Kewaunee..... | 2,000 | New plant | -- |
| Kewaskum..... | 800 | Replacement | Planning initiated |
| Kimberly: | | | |
| Combined Locks Paper Co..... | 8,064 | Enlargement | Under order, construction authorized |
| Kimberly-Clark Paper Co. (Pulp)..... | 420,840 | New plant | Under order, construction authorized |
| Marion..... | 800 | New plant | Planning initiated |
| Markesan..... | 910 | Replacement | Under order |
| Milwaukee..... | 730,000 | Enlargement | Construction authorized<br>Actual population equivalent of 2,200,000 |
| Mishicot: | | | |
| Mishicot Dairy Products Co.. | 1,000 | New plant | Under order; planning initiated to connect to city sewer in lieu of new plant |
| Neenah: | | | |
| Bergstrom Paper Co..... | 2,640 | Enlargement | Under order, planning initiated |
| Neopit: | | | |
| Indian Reservation..... | 1,200 | New plant | Construction authorized |
| New London..... | 4,825 | New plant | -- |
| Hamilton & Sons Canning Co.. | PEU**** | New plant | -- |
| Niagara..... | 2,000 | New plant | Plans approved |
| K. C. Pulp & Paper Mill (Pulp)..... | 360,000 | New plant | -- |
| Nichols..... | 175 | New plant | -- |
| Oconto..... | 5,700 | New plant | Under order, planning initiated |
| American Veneer Corp..... | 30 | New plant | Planning initiated |
| Bond Pickle Co..... | 2,200 | New plant | Under order, planning initiated |
| Dried Egg Co..... | 3,966 | New plant | Under order, planning initiated |
| Oconto Brewing Co..... | 9,800 | New plant | Under order, planning initiated |

See footnotes at end of table.

Table $I_2$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

| Name | Population served** | Project requirements | Remarks |
|---|---|---|---|
| WISCONSIN--Continued | | | |
| Oconto Falls | 1,888 | New plant | Under order, plans approved |
| Carnation Milk Co. | 230 | New plant | Under order, planning initiated |
| Falls Canning Co. | 2,880 | New plant | Under order, planning initiated |
| Falls Paper & Power Co. (Pulp) | 166,000 | New plant | Under order |
| Pardeeville: | | | |
| Pardeeville Canning Co. | PEU**** | New plant | -- |
| Peshtigo | 1,700 | New plant | Under order |
| Badger Paper Mills (Pulp) | 270,000 | New plant | Under order |
| Port Washington | 3,600 | New plant | -- |
| Pulaski: | | | |
| Pulaski Canning Co. | PEU**** | New plant | -- |
| Ripon | 3,800 | Enlargement | Plans approved |
| St. Nazianz: | | | |
| Valders Canning Co. | PEU**** | New plant | -- |
| Saukville | 431 | New plant | Plans approved |
| Seymour | 1,000 | Enlargement | -- |
| Sheboygan Falls: | | | |
| Anglo-American Tanning Co. | PEU**** | New plant | Under order, construction authorized |
| Grieves Woolen Mill | PEU**** | New plant | Under order, construction authorized |
| Shiocton: | | | |
| Shiocton Kraut Co. | PEU**** | New plant | -- |
| South Lawn Sanitary District | 750 | New plant | -- |
| South Milwaukee | 10,400 | Enlargement | Plans approved |
| Sturgeon Bay: | | | |
| Fruit Growers Corp. | PEU**** | New plant | -- |
| Sturtevant | 650 | Replacement | -- |
| Union Grove: | | | |
| Union Grove Training School | 855 | Replacement | Construction authorized |
| Valders | 450 | Enlargement | -- |
| Valders Canning Co. | PEU**** | New plant | -- |
| Vinland: | | | |
| (Winnebago County) Grand View Dairies | PEU**** | New plant | Under order |
| Winneconne: | | | |
| Winneconne Corp. | PEU**** | New plant | -- |
| Wrightstown | 700 | New plant | Under order, construction authorized |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**Population equivalent for industry.

***Name of industry withheld at the request of Illinois Sanitary Water Board.

****PEU is abbreviation for Population Equivalent Undetermined.

## LAKE MICHIGAN (EASTERN SHORE) SUB-BASIN

All of the area tributary to Lake Michigan from the east and southeast form the sub-basin referred to in this report as Lake Michigan (Eastern Shore). It includes that portion of the Calumet River which flows into Lake Michigan through the Indiana Harbor Ship Canal and also drainage to the lake through Burns Waterway.

The sub-basin is generally rectangular in shape being 320 miles long along the north-south axis and 110 miles wide along the east-west axis. The sub-basin contains 24,000 square miles, 90 percent in Michigan and ten percent in Indiana. The highest elevation in the area is near Cadillac, Mich., which is 1,713 feet above sea level.

Principal tributaries to the lake include the Manistee, Muskegon, Grand, Kalamazoo, St. Joseph and the Calumet. These streams are not large and are generally unsuited for commercial navigation with the exception of the lower 17 1/2 miles of the Grand River which is improved and used for a large tonnage of commercial navigation. (However, Congress has approved (1946), improvement of the Calumet for commercial navigation to Clark Street, in Gary, Ind.) Bottom gradients are not steep and the drainage area has localized flooding problems. The rivers are not used as sources of municipal water supply, because an ample ground water source of suitable quality is readily available throughout most of the sub-basin.

The natural lakes connecting with Lake Michigan at the mouths of several of the rivers form excellent harbors for both commercial and recreational navigation and together comprise one of the attractions on which the large recreational industry is based.

The topography of the area is the result of the glacial periods; the deposited soils are largely glacial till and are very fertile in some locations. The region has gently rolling hills with a number of rather large streams and lakes. The climate of the sub-basin varies from continental to semimarine, depending on wind movement. The average January temperature varies from 12°F. to 26°F. and the corresponding average July temperature ranges from 66°F. to 72°F. The growing season is between 100 and 180 days long; the average annual precipitation is between 28 inches and 32 inches with over 50 percent occurring in the warm season.

The population of the sub-basin was 2,272,260 in 1950, and although the region contains a number of highly populated municipalities yet the rural areas have a fairly large percentage of the total population. The major cities include Traverse City, Cadillac, Muskegon, Grand Rapids, Lansing, Jackson, Kalamazoo, Battle Creek, Benton Harbor, South Bend, Mishawaka, Elkhart, and Gary. These communities are all on rivers or on Lake Michigan, showing the importance of waterways in the original location and growth of the cities.

The automotive industry, steel production, recreation, oil refining, paper production, and fruit growing are the significant industries of the drainage area. However, metal working machinery and furniture manufacture and food processing and packaging are also of importance. This area contains some of the finest fruit orchards and vineyards in the mid-west. The Calumet area of Indiana is world famous for its steel mills and large oil refineries. In addition, one of the world's largest breakfast food packaging centers is located in the sub-basin.

One hundred and seventy-five sewered municipalities serving 1,287,000 people are located in this sub-basin. Of this number, 42 municipalities provide secondary treatment serving 398,000 people and 51 municipalities provide primary treatment serving 464,000 people. Of the 82 municipalities which do not provide treatment, 16 have populations less than 500, 12 have populations between 500 and 1,000, 31 have populations between 1,000 and 2,500, and 23 have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by 137 industries, 94 of which have provided treatment for their wastes.

Table $E_3$ is an analysis of the adequacy of existing treatment facilities. This table indicates that 42 of the municipal and 32 of the industrial waste treatment plants have unsatisfactory capacity and that the operation should be improved at six municipal and ten industrial waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in table $G_3$. This shows that 64 new municipal plants are needed and that 34 existing plants need enlargement or additions. Eight plants are reported to need replacement. It is also noted that 22 new industrial waste treatment plants are needed while 26 are in need of enlargement or additions. Six existing industrial waste treatment plants, it is reported, need to be replaced.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

| Population group | New plant | Enlargement or additions to existing plant | Replace existing plant | Undetermined |
|---|---|---|---|---|
| Less than 500 . | 9 | 0 | 2 | 6 |
| 500 to 1,000 .. | 8 | 1 | 1 | 2 |
| 1,000 to 2,500. | 24 | 11 | 2 | 4 |
| Over 2,500 ... | 23 | 22 | 3 | 0 |
| Total..... | 64 | 34 | 8 | 12 |

Table F 3 indicates steady progress in construction of municipal sewage treatment works from 1946 to 1949. From only one plant constructed in 1946 the rate increased to six plants in 1949, these six plants being designed to serve 129,500 people. Construction of industrial waste treatment works has also increased steadily. In 1946, three plants treating wastes with a population equivalent of 115,000 were built, while in 1948 ten plants were built, and in 1949 eight plants were constructed. In addition during 1948, seven industries completed connections to adjacent municipal sanitary sewers for disposal of industrial wastes, while in 1919 six industries made similar connections for the same purpose.

Considerable activity by State water pollution control agencies is shown in table H 3. Thirty-two municipalities and seven industries are under orders to abate pollution and 44 municipalities and 28 industries have initiated plan preparation. Final plans have been approved for 26 municipal and three industrial waste treatment plants. Four municipal sewage treatment works and seven industrial waste treatment works are under construction.

Perhaps the most important water use in the sub-basin is recreational. Boating, swimming, and fishing are very popular in this area which is famous for its resorts, lakes, woods, and parks. However, municipal and industrial water supply, navigation, and stockwatering have considerable significance. Water power has been developed on a number of the streams and flood control projects have been considered for some.

Municipal and industrial wastes with a total population equivalent of 400,000 have harmed livestock watering, game fishing, and wildlife in the St. Joseph River in the Elkhart-Mishawaka-South Bend area. Municipal and industrial wastes reaching the Grand River at Grand Rapids have seriously harmed game fishing and public and riparian interests. The Kalamazoo River from Comstock to the mouth of the stream receives pulp and paper mill wastes with a population equivalent of nearly 600,000 as well as municipal wastes. This serious pollution has damaged livestock watering, game fishing, and public interest generally in the Kalamazoo River.

The pollution of the lower end of Lake Michigan has been the subject of litigation brought before the U. S. Supreme Court. In the case Illinois vs. Indiana, et al. (Original No. 9), the State of Illinois claimed that the wastes discharged to the southern end of Lake Michigan were causing serious pollution which was damaging the Chicago public water supply.

In the hearings before the special master appointed by the court, the defendants entered into stipulations which were acceptable to the plaintiff. In these stipulations the defendants agreed to construct certain remedial works which are estimated to cost nearly $15,000,000. All of the proposed work has been completed and the case was dismissed by the court in November, 1950.

Pollution abatement orders were issued by the Indiana Stream Pollution Control Board in 1945 to the cities of South Bend, Mishawaka, and Elkhart. A joint meeting of Indiana and Michigan water pollution control agencies was held with officials of the cities in attendance. Subsequently, the cities agreed to build the needed treatment facilities without further delay.

Recreational water use and municipal water supply possibly are the uses which have suffered the most through pollution. However, industrial use and stockwatering have also been harmed in this area.

Other less important polluting conditions exist in the sub-basin, but will not be discussed because this report is not intended to cover all individual polluting problems.

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (tables B and I), the population equivalent of the waste was used when known.

Table $A_3$. Sources of pollution, municipal

| Municipalities* | Sources of pollution (in number of municipalities)** | Population served by sewerage system | Amount of pollution discharged to watercourse (in terms of equivalent number of people)*** |
|---|---|---|---|
| Having data on pollution load discharged to watercourse | 28 | 368,510 | 436,094 |
| Having population data available (Data on pollution load to watercourse incomplete or not available) | 147 | 918,151 | Not applicable |
| Total | 175 | 1,286,661 | -- |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes all municipalities, etc. with sewer systems regardless of status of treatment or magnitude of the problem created. Reference to tables C and E is necessary to determine number of municipalities with treatment and the adequacy of such treatment.

***Includes industrial wastes discharged into municipal sewerage systems.

Table $B_3$. Sources of pollution, industrial

| Industries | Sources of pollution (in number of plants)* | Amount of pollution discharged to watercourse (in terms of equivalent number of people) |
|---|---|---|
| Producing organic wastes | 40** | 689,443 |
| Producing organic wastes | 62 | Undetermined |
| Producing inorganic wastes | 39 | Not applicable |
| Producing wastes of undetermined type | 0 | Undetermined |
| Total | 137*** | -- |

*Includes all industries with outlets for the discharge of waste to the watercourse regardless of the status of treatment or magnitude of the problem created. Reference to tables D and E is necessary to determine the number of industries with treatment and the adequacy of such treatment.

**Includes 4 plants also producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus, **.

Table $C_3$.
Existing treatment facilities, municipal

| Degree of treatment provided | Number | | Population served |
|---|---|---|---|
| | Municipalities* | Plants | |
| Primary | 51 | 51 | 464,128 |
| Secondary | 42 | 41 | 398,213 |
| No treatment | 82 | -- | 424,320 |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table $D_3$. Existing treatment facilities, industrial*

| Type industry | Number of plants | Number of industrial plants having: | | |
|---|---|---|---|---|
| | | Treatment facilities | No treatment facilities | Undetermined facilities |
| Food and kindred products..... | 57 | 35 | 22 | 0 |
| Textile mill products..... | 1 | 0 | 1 | 0 |
| Paper and allied products..... | 27 | 20 | 7 | 0 |
| Chemical and allied products..... | 23 | 18 | 4 | 1 |
| Products of petroleum and coal..... | 4 | 4 | 0 | 0 |
| Rubber products..... | 1 | 0 | 1 | 0 |
| Leather and leather products..... | 3 | 3 | 0 | 0 |
| Primary metal industries.. | 1 | 0 | 1 | 0 |
| Fabricated metal products..... | 12 | 8 | 4 | 0 |
| Miscellaneous..... | 3 | 1 | 2 | 0 |
| Oil production industry... | 5 | 5 | 0 | 0 |
| Total..... | 137 | 94 | 42 | 1 |

* Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_3$. Adequacy of existing treatment facilities

| Existing treatment facilities | Number | Adequacy with relation to: | | | | | |
|---|---|---|---|---|---|---|---|
| | | Capacity | | | Operation | | |
| | | Satisfactory | Unsatisfactory | Undetermined | Satisfactory | Unsatisfactory | Undetermined |
| Municipal | 92 | 47 | 42 | 3 | 82 | 6 | 4 |
| Industrial | 94 | 49 | 32 | 13 | 62 | 10 | 22 |

Table $F_3$. Progress in pollution abatement

| Year | Municipal | | Industrial | |
|---|---|---|---|---|
| | Plants completed | Design population | Plants completed | Amount of waste treated (in terms of equivalent number of people) |
| 1946 | 1 | Undetermined | 3 | 115,000* |
| 1947 | 1 | 1,000 | 1 | 6,000 |
| 1948 | 4 | 5,500 | 17** | 17,250[1] |
| 1949 | 6 | 129,500 | 14[2] | 35,000[3] |

*One industry discharged acid and alkali wastes.

**Includes 7 industries completing sanitary connections to adjacent municipalities. Treatment population equivalent undetermined.

[1] One industry discharged cyanides, and one plant chemical wastes.

[2] Includes 6 industries completing sanitary sewer connections to adjacent municipalities having treatment population equivalent undetermined for 5.

[3] Three industries discharged oil wastes.

Table $G_3$. Requirements for municipal and industrial waste treatment plants*

| Requirements | Municipal | | Industrial |
|---|---|---|---|
| | Number | Population served by facilities | Number |
| New plant | 64 | 409,564 | 22 |
| Enlargement or additions to existing plant | 34 | 613,190 | 26 |
| Replace existing plant | 8 | 25,703 | 6 |
| No project required | 56 | 229,024 | 57 |
| Undetermined** | 12 | 9,180 | 26 |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**Includes nine municipal and eight industrial minor sources of pollution not included in table $E_3$ for which existing disposal methods are considered satisfactory for present stream conditions.

Table $H_3$. Status of treatment works project to abate pollution, July 1, 1950

| Status of project | Number | |
|---|---|---|
| | Municipal | Industrial |
| No formal action | 11 | 4 |
| Abatement ordered | 32 | 7 |
| Plans under preparation | 44 | 28 |
| Final plans approved | 26 | 3 |
| Construction awaiting financing | 5 | 0 |
| Under construction | 4 | 7 |
| Status undetermined | 28 | 38 |

**Table I3. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950**

| Name | Population served ** | Project requirements | Remarks |
|---|---|---|---|
| INDIANA | | | |
| Albion | 1,934 | New plant | -- |
| Chesterton | 2,470 | New plant | -- |
| Crown Point | 4,643 | New plant | Under order; plans approved |
| East Gary | 3,401 | New plant | -- |
| Elkhart | 40,000 | New plant | Under order; awaiting financing |
| Fremont | 855 | New plant | Plans approved |
| Goshen | 11,375 | Enlargement | -- |
| Hobart | 7,166 | New plant | Under order; plans approved |
| Kendallville | 5,431 | Enlargement | -- |
| LaGrange | 1,814 | New plant | Plans approved; under order |
| Gordon Baking Co. | PEU*** | New plant | Plans approved for connection to city sewers in lieu of new plant |
| Lake County T. B. Sanitarium | 412 | New plant | May connect to proposed Crown Point plant |
| Michigan City | 26,476 | Enlargement | Awaiting financing |
| Milford | 901 | New plant | -- |
| Mishawaka | 50,000 | New plant | Under order; awaiting financing |
| Nappanee | 3,028 | New plant | Plans approved; under order |
| Porter | 1,190 | New plant | -- |
| Schererville | 998 | New plant | -- |
| South Bend | 293,000 | New plant | Interceptor under construction; under order |
| Gentner Packing Co. | PEU*** | New plant | Plans approved |
| St. Mary's College<br>University of Notre Dame | -- | -- | May connect to proposed South Bend System for treatment. |
| Syracuse | 1,346 | New plant | Planning initiated |
| Valparaiso | 8,736 | New plant | Under order |
| Wakarusa | 1,033 | New plant | Planning initiated |
| MICHIGAN | | | |
| Albion | 8,345 | New plant | Construction authorized; under order |
| Allegan | 4,526 | Enlargement | Planning initiated |
| Amble: | | | |
| Rockwood & Co. | PEU*** | New plant | Construction initiated |
| Battle Creek | 72,000 | Enlargement | Planning initiated; under order for cyanide in effluent |
| Grand Trunk R.R. car shops | -- | New plant | Oil waste |
| Battle Creek Township | PEU*** | New plant | Plans approved |
| Bay View Association | 2,000 | Enlargement | Planning initiated |
| Belding | 4,090 | New plant | Planning initiated |
| Bellevue | 1,010 | New plant | Planning initiated |
| Benton Harbor | 16,668 | New plant | Plans approved; under order |
| Benton Township | 10,000 | New plant | Planning initiated; under order |
| Beulah | 378 | New plant | Planning initiated; under order |
| Big Rapids | 5,000 | New plant | Planning initiated; under order |
| Boyne City | 2,900 | New plant | Planning initiated |
| Howes Leather Co. | 7,800 | Enlargement | Planning initiated |

See footnotes at end of table.

Table I3. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

| Name | Population served ** | Project requirements | Remarks |
|---|---|---|---|
| MICHIGAN--Continued | | | |
| Bronson | 1,871 | New plant | Planning initiated |
| Bronson Plating Co. | -- | Replacement | Inorganic waste; planning initiated; under order |
| H. A. Douglas Co. | -- | Replacement | Inorganic waste; planning initiated; under order |
| L. A. Darling Co. | -- | Replacement | Inorganic waste; under order |
| Cassopolis | 1,488 | Enlargement | Plans approved |
| Charlotte | 5,540 | Enlargement | Planning initiated; under order |
| Coldwater | 7,343 | Replacement | Plans approved; under order |
| Coopersville | 1,100 | Enlargement | Planning initiated |
| Coloma | 960 | New plant | Plans approved |
| Coloma Township | PEU*** | New plant | Planning initiated |
| Constantine | 1,384 | New plant | Planning initiated |
| Dewitt: | | | |
| Rosevale Packing Co. | PEU*** | Replacement | Construction authorized |
| East Jordan | 1,725 | New plant | Planning initiated |
| East Lansing | 25,000 | Enlargement | Planning initiated |
| Eaton Rapids | 3,060 | New plant | Planning initiated |
| Horner Woolen Mills Co. | PEU*** | New plant | Planning initiated |
| Elberta | 620 | New plant | Planning initiated |
| Elk Rapids | 690 | New plant | Planning initiated; under order |
| Ellsworth: | | | |
| Reid-Murdock Co. | PEU*** | Enlargement | Planning initiated |
| Fillmore: | | | |
| Fillmore Creamery | PEU*** | Replacement | Under order |
| Fremont | 2,520 | Enlargement | Planning initiated |
| Grand Rapids | 180,000 | Enlargement | Planning initiated; under order |
| American Box Board Co. | 35,300 | Enlargement | Planning initiated |
| Grand Rapids Packing Co. | 2,050 | Replacement | Planning initiated; under order |
| Grandville | 1,566 | Enlargement | Planning initiated; under order |
| Greenville | 5,320 | Enlargement | Planning initiated |
| Gibson Refrigerator Co. | -- | Enlargement | Inorganic waste |
| Hart | 1,922 | New plant | Plans approved |
| Hastings | 5,180 | Enlargement | Plans approved |
| Hillsdale | 6,381 | New plant | Awaiting financing; under order |
| Ionia | 6,400 | New plant | Planning initiated |
| Jackson: | | | |
| Hillfinger Co., Inc. | -- | Enlargement | Inorganic waste |
| Jackson Hard Chrome Plating Co. | -- | New plant | Inorganic waste; planning initiated |
| Michner Plating Co. | -- | Enlargement | Inorganic waste; planning initiated |
| New York Central R. R. Yards | -- | New plant | Oil wastes |
| Pittsburg Forging Co. | -- | Enlargement | Inorganic waste |
| Kalamazoo | 60,300 | New plant | Plans approved |
| Allied Paper Co. (Monarch Division) | 60,580 | New plant | Planning initiated |

See footnotes at end of table

Table I$_3$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

| Name | Population served ** | Project requirements | Remarks |
|---|---|---|---|
| MICHIGAN--Continued | | | |
| Allied Paper Co. (King Division) | 97,900 | New plant | Planning initiated |
| Hawthorne Paper Co. | 11,300 | New plant | -- |
| Kalamazoo Paper Co. | 81,500 | New plant | -- |
| National Gypsum Co. | 18,270 | New plant | -- |
| Rex Paper Co. | 16,300 | New plant | Planning initiated |
| St. Regis Paper Co. | 66,530 | New plant | Planning initiated |
| Sutherland Paper Co.: | | | |
| Divisions 1, 2, 3 | 5,820 | Enlargement | Planning initiated |
| Division 4 | 20,680 | Enlargement | Planning initiated |
| Division 7 | 5,000 | Enlargement | Planning initiated |
| Kalamazoo Township | 25,000 | New plant | Plans approved |
| Lake Odessa | 1,420 | Enlargement | Planning initiated; under order |
| Lansing | 78,750 | Enlargement | Construction authorized |
| Michigan Sugar Co. | 38,400 | Enlargement | Under order |
| Lawrence | 679 | Replacement | Construction authorized |
| Lawton: | | | |
| Welch Grape Juice Co. | 32,000 | Enlargement | Planning initiated |
| Leslie | 1,280 | New plant | Planning initiated |
| Lowell | 1,950 | Enlargement | -- |
| Manistee: | | | |
| American Box Board Co. | 180,000 | Enlargement | Planning initiated |
| Marshall | 5,250 | New plant | Awaiting financing; under order |
| Mason | 2,870 | Enlargement | Planning initiated |
| Muskegon | 49,700 | Enlargement | Plans approved |
| Central Paper Co. | -- | Enlargement | Inorganic waste; construction authorized |
| Continental Motors | -- | New plant | Inorganic waste; construction authorized |
| Muskegon Heights | 16,050 | Enlargement | Planning initiated; under order |
| Northport: | | | |
| Northport Canning Co. | PEU*** | Enlargement | Construction authorized |
| Otsego | 3,428 | New plant | -- |
| Mac Sim Bar Paper Co. | 32,475 | New plant | Planning initiated |
| Otsego Falls Paper Co. | 114,700 | New plant | -- |
| Parchment | 1,450 | New plant | Planning initiated |
| Kalamazoo Vegetable Parchment Co. | 27,000 | Enlargement | Planning initiated |
| Petoskey | 6,020 | Enlargement | Under order; planning initiated |
| Plainwell | 2,424 | New plant | Planning initiated |
| Michigan Paper Co. | 20,000 | Enlargement | Planning initiated |
| Portland | 2,247 | New plant | Plans approved |
| Reed City | 1,845 | Replacement | Plans approved |
| Rockford: | | | |
| Rockford Paper Mills | 4,622 | New plant | Planning initiated |
| Saugatuck | 628 | New plant | Planning initiated |
| Sparta | 1,945 | Enlargement | Planning initiated |
| State Prison of South Michigan | 5,200 | Enlargement | Awaiting financing |
| St. Johns | 4,420 | Replacement | Planning initiated |
| St. Joseph | 8,963 | New plant | Awaiting financing; under order |
| Sturgis | 7,214 | Enlargement | Planning initiated; under order |

See footnotes at end of table.

Table I3. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

| Name | Population served ** | Project requirements | Remarks |
|---|---|---|---|
| MICHIGAN--Continued | | | |
| Suttons Bay: | | | |
| Frigid Food Products..... | PEU*** | New plant | Under order |
| Three Rivers..... | 6,710 | New plant | Planning initiated |
| Rocky River Paper Co. ..... | PEU*** | New plant | Under order; construction authorized |
| Eddy Paper Corp. ..... | -- | New plant | Planning initiated |
| Union Pier..... | 275 | New plant | -- |
| Vicksburg..... | 1,774 | New plant | Planning initiated |
| Lee Paper Co. ..... | 12,800 | Enlargement | Planning initiated |
| Watervliet..... | 1,193 | Enlargement | Plans approved |
| Watervliet Paper Co. ..... | 43,000 | Enlargement | Planning initiated |
| White Pigeon..... | 1,017 | New plant | Plans approved |
| Eddy Paper Co. ..... | PEU*** | Enlargement | Construction authorized |
| Williamston..... | 1,700 | New plant | Plans approved |
| Wyoming Township..... | 7,930 | New plant | Under order; planning initiated |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in changes in these needs.

**Population equivalent for industry.

***PEU is abbreviation for Population Equivalent Undetermined.

## LAKE HURON SUB-BASIN

This sub-basin lies along the western shore of Lake Huron and contains approximately half of the inland peninsula formed by Lake Huron and Lake Michigan. The drainage area is thus formed by the western shore of Lake Huron and the watershed divide between Lake Huron and Lake Michigan.

The sub-basin has a maximum northwest-southeast length of 208 miles and a maximum width of 112 miles containing an area of 14,981 square miles; it is very irregular in shape due to the projection of Saginaw Bay and the wandering watershed line.

The primary drainage system in the sub-basin is the Saginaw itself, and its four important tributaries, namely, the Tittabawassee, Shiawassee, Flint, and Cass Rivers. The Thunder Bay River and the Au Sable River drain directly to the lake. Numerous small rivers and creeks are tributary to the above-named rivers; and others flow directly into Lake Huron. Swamps and lakes comprise approximately ten percent of the sub-basin area.

Most of the streams are characterized by slight gradients throughout the flat lowlands adjacent to the shore line. However, the gradients become appreciably steeper in the upper reaches of the drainage area. In the case of the Saginaw River, the gradient is so slight that reversals of flow have occurred.

The soil of the lowlands is sedimentary in nature, being mostly a sandy till or a gravelly loam. Nearer the headwaters of the rivers, the soil becomes a clayey till.

The sub-basin has a moderate, cool climate. The average January temperature ranges from 18°F. in the north to 24°F. in the south, with average July temperatures being 66°F. to 72°F, respectively. The growing season varies from 90 days to 150 days with an average annual precipitation between 28 and 30 inches, 50 percent to 60 percent falling in the growing season.

Genesee County has the largest concentration of population with 350 persons per square mile, but the concentration decreases to as low as 15 persons per square mile in the sparsely settled northern counties.

The Saginaw Valley is the chief industrial center of the region, although a few industrial establishments exist in the northern port cities. Some of the more important industries are automobile and automotive parts manufacturing, chemical plants, oil and gas fields and refineries, and some coal mining. Agriculture is relatively unimportant except in the fertile southern part of the area.

Eighty-one sewered municipalities serving 379,000 people are located in this sub-basin. Of this number, 21 municipalities provide secondary treatment serving 178,000 people and 11 municipalities provide primary treatment serving 45,800 people. Of the 49 municipalities which do not provide treatment, 15 have populations less than 500, 12 have populations between 500 and 1,000, 15 have populations between 1,000 and 2,500, and seven have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by 57 industries, 35 of which have provided treatment for their wastes.

Table $E_4$ is an analysis of the adequacy of existing treatment facilities. This table indicates that 11 of the municipal and ten of the industrial waste treatment plants have unsatisfactory capacity and that the operation should be improved at two municipal and five industrial waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in Table $G_4$. This shows that 32 new municipal plants are needed and that nine existing plants need enlargement or additions. Two plants are reported to need replacement. It is also noted that 13 new industrial waste treatment plants are needed while six are in need of enlargement or additions. Four existing industrial waste treatment plants, it is reported, need to be replaced.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

| Population group | New plant | Enlargement or additions to existing plant | Replace existing plant | Undetermined |
|---|---|---|---|---|
| Less than 500..... | 7 | 0 | 0 | 2 |
| 500 to 1,000 ... | 5 | 0 | 0 | 0 |
| 1,000 to 2,500 ... | 13 | 2 | 1 | 1 |
| Over 2,500 ... | 7 | 7 | 1 | 0 |
| Total.... | 32 | 9 | 2 | 3 |

Construction of waste treatment plants has been deterred in this sub-basin for various reasons. During 1946 to 1949 only three municipal treatment plants and nine industrial waste treatment works were built. Municipal plants served a design population of 7,000, while industrial waste treatment works handled wastes having a population equivalent of 182,500. Material shortages were the principal obstacle to construction during this period. As shown in table H4 a number of municipal and industrial waste treatment plant projects are in various stages of planning. Final completion of these plants will depend largely on the availabi'ity of materials and contractors.

The principal water uses are recreational and industrial water supply, while other primary uses include navigation and municipal water supply. Navigation is important to the cities on the Saginaw Bay, along the Saginaw River, and to the cities along the northern coast of the peninsula.

One of the better examples of damage done to recreational waters by pollution in this watershed is found near the mouth of the Thunder Bay River which is receiving gross pollution from municipal and industrial wastes. Formal steps, such as hearings and abatement orders, have been taken by the State of Michigan to eliminate much of this pollution. Hearing testimony reveals that fish kills have occurred and portions of the river have been condemned for any recreational purposes.

From a monetary standpoint, probably the highest pollution problem has centered around Saginaw Bay where public water supply, commercial fishing, and navigation have been damaged. In addition to municipal sewage, there are considerable sources of industrial waste discharges in Saginaw, Bay City and Midland. Most of these wastes are chemical in nature including phenols, chlorides, cyanides, oils, acids, and other toxic wastes. As a direct result, the cities of Saginaw and Midland jointly invested $10,300,000 in a pipe line to Lake Huron to obtain a pollution-free source of water for their public water supplies. This project started continuous operation in October, 1948.

Commercial and gamefishing have been harmed in Lake Huron near Sebewaing due to municipal and industrial wastes. The Saginaw River from Saginaw to Saginaw Bay has received untreated wastes from over 40 industries and 130,000 people. The resulting pollution has harmed water supply and navigation. Municipal wastes have damaged livestock watering and game fishing in the Flint River, while untreated domestic sewage and refinery and food processing plant wastes have impaired livestock watering and game fishing in the Chippewa River.

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (tables B and I), the population equivalent of the waste was used when known.

Table $A_4$. Sources of pollution, municipal

| Municipalities* | Sources of pollution (in number of municipalities)** | Population served by sewerage system | Amount of pollution discharged to watercourse (in terms of equivalent number of people)*** |
|---|---|---|---|
| Having data on pollution load discharged to watercourse | 0 | -- | -- |
| Having population data available (Data on pollution load to watercourse incomplete or not available) | 81 | 378,969 | Not applicable |
| Total | 81 | 378,969 | -- |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes all municipalities, etc. with sewer systems regardless of status of treatment or magnitude of the problem created. Reference to table C and E is necessary to determine number of municipalities with treatment and the adequacy of such treatment.

***Includes industrial wastes discharged into municipal sewerage systems.

Table $B_4$. Sources of pollution, industrial

| Industries | Sources of pollution* (in number of plants) | Amount of pollution discharged to watercourse (in terms of equivalent number of people) |
|---|---|---|
| Producing organic wastes | 15** | 489,244 |
| Producing organic wastes | 29 | Undetermined |
| Producing inorganic wastes | 16 | Not applicable |
| Producing wastes of undetermined type | 0 | Undetermined |
| Total | 57*** | -- |

*Includes all industries with outlets for the discharge of waste to the watercourse regardless of the status of treatment or magnitude of the problem created. Reference to tables D and E is necessary to determine the number of industries with treatment and the adequacy of such treatment.

**Includes 3 plants also producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus,**.

Table $C_4$.
Existing treatment facilities, municipal

| Degree of treatment provided | Number | | Population served |
|---|---|---|---|
| | Municipalities* | Plants | |
| Primary | 11 | 11 | 45,771 |
| Secondary | 21 | 21 | 178,153 |
| No treatment | 49 | -- | 155,045 |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table $D_4$. Existing treatment facilities, industrial*

| Type industry | Number of plants | Number of industrial plants having: | | |
|---|---|---|---|---|
| | | Treatment facilities | No treatment facilities | Undetermined facilities |
| Food and kindred products.. | 33 | 16 | 17 | 0 |
| Lumber and wood products... | 0 | 0 | 0 | 0 |
| Paper and allied products.. | 1 | 1 | 0 | 0 |
| Chemical and allied products..... | 7 | 3 | 4 | 0 |
| Leather and leather products..... | 2 | 1 | 1 | 0 |
| Primary metal industries... | 2 | 2 | 0 | 0 |
| Fabricated metal products.. | 3 | 3 | 0 | 0 |
| Miscellaneous..... | 3 | 3 | 0 | 0 |
| Oil production industry.... | 6 | 6 | 0 | 0 |
| Total..... | 57 | 35 | 22 | 0 |

*Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_4$. Adequacy of existing treatment facilities

| Existing treatment facilities | Number | Adequacy with relation to: | | | | | |
|---|---|---|---|---|---|---|---|
| | | Capacity | | | Operation | | |
| | | Satisfactory | Unsatisfactory | Undetermined | Satisfactory | Unsatisfactory | Undetermined |
| Municipal | 32 | 19 | 11 | 2 | 26 | 2 | 4 |
| Industrial | 35 | 21 | 10 | 4 | 26 | 5 | 4 |

Table $F_4$. Progress in pollution abatement

| Year | Municipal | | Industrial | |
|---|---|---|---|---|
| | Plants completed | Design population | Plants completed | Amount of waste treated (in terms of equivalent number of people) |
| 1946 | 1 | Undetermined | 3 | 181,500* |
| 1947 | none | -- | none | -- |
| 1948 | 2 | 7,075 | 2 | Undetermined |
| 1949 | none | -- | 4 | 1,000 |

*One industry discharged cyanides.

Table $G_4$. Requirements for municipal and industrial waste treatment plants*

| Requirements | Municipal | | Industrial |
|---|---|---|---|
| | Number | Population served by facilities | Number |
| New plant | 32 | 144,610 | 13 |
| Enlargement or additions to existing plant | 9 | 190,557 | 6 |
| Replace existing plant | 2 | 4,810 | 4 |
| No project** required | 35 | 36,992 | 25 |
| Undetermined | 3 | 2,000 | 9 |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in changes in these needs.

**Includes 16 municipal and four industrial minor sources of pollution not included in table $E_4$ for which existing disposal methods are considered satisfactory for present stream conditions.

Table $H_4$. Status of treatment works project to abate pollution, July 1, 1950

| Status of project | Number | |
|---|---|---|
| | Municipal | Industrial |
| No formal action | 6 | 1 |
| Abatement ordered | 15 | 8 |
| Plans under preparation | 16 | 13 |
| Final plans approved | 6 | 0 |
| Construction awaiting financing | 7 | 2 |
| Under construction | 4 | 3 |
| Status undetermined | 7 | 13 |

Table I4. Project list - municipalities and industries requiring improvements for abatement of pollution,* July 1, 1950

| Name | Population served** | Project requirements | Remarks |
|---|---|---|---|
| MICHIGAN | | | |
| Alma | 7,200 | Enlargement | -- |
| Leonard Refining Co. | Not applicable | Replacement | Planning initiated |
| Michigan Sugar Co. | 66,000 | Enlargement | Planning initiated; under order |
| Alpena | 12,809 | New plant | Awaiting financing |
| Alpena Tanning Corp. | PEU*** | New plant | Planning initiated |
| Bay City | 47,956 | New plant | Under order; awaiting financing |
| Bay Manufacturing Division Electric Auto-Lite Co. | Not applicable | New plant | Planning initiated; awaiting financing |
| H. D. Peet Packing Co. | PEU*** | New plant | Planning initiated |
| Nichols-Foss Packing Co. | PEU*** | New plant | Planning initiated |
| Monitor Sugar Co. | 44,000 | Enlargement | Under order |
| Bad Axe | 2,624 | Replacement | Under order; planning initiated |
| Fairmont Foods Co. | PEU*** | Replacement | Under order |
| Caro | 3,070 | Enlargement | Under order; awaiting financing |
| Cass City | 1,360 | Enlargement | -- |
| Cheboygan | 5,673 | New plant | Under order; plans approved |
| Clare | 1,845 | New plant | Plans approved; under order |
| Conway | 150 | New plant | Under order |
| Corruna | 2,020 | New plant | Planning initiated |
| Davison | 1,400 | New plant | Construction authorized |
| Essexville | 2,390 | New plant | Plans approved |
| Flint | 151,543 | Enlargement | Construction authorized; under order |
| Burton Township | PEU*** | New plant | Planning initiated |
| Flint Township | PEU*** | New plant | Planning initiated |
| Genesee Township | PEU*** | New plant | Planning initiated |
| Mt. Morris Township | PEU*** | New plant | Planning initiated |
| General Motors Corp., Buick Division | Not applicable | Enlargement | Planning initiated |
| Flushing | 1,810 | New plant | Awaiting financing |
| Frankenmuth | 1,100 | New plant | Planning initiated |
| Frankenmuth Brewing Co. | 25,000 | New plant | Planning initiated |
| Gladwin | 1,600 | New plant | Planning initiated; under order |
| Harbor Beach | 2,186 | Replacement | Planning initiated |
| Huron Milling Co. | 92,300 | Enlargement | Planning initiated |
| Holly | 2,343 | New plant | -- |
| Ithaca | 2,000 | Enlargement | -- |
| Lapeer | 5,365 | New plant | Plans approved; under order |
| Lapeer State Home and Training School | 4,060 | Enlargement | Under construction |
| Marlette | 580 | New plant | Planning initiated |
| Mt. Morris | 2,240 | New plant | Planning initiated |
| Mt. Pleasant | 8,415 | New plant | Awaiting financing |
| Borden Milk Co. | 803 | New plant | Planning initiated |
| Oscoda | 660 | New plant | -- |
| Owosso | 14,424 | Enlargement | Plans approved |
| Pinconning | 1,027 | New plant | Construction authorized |
| Roscommon | 300 | New plant | Under order |

See footnotes at end of table.

Table I4. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

| Name | Population served** | Project requirements | Remarks |
|---|---|---|---|
| MICHIGAN--Continued | | | |
| Saginaw | 82,800 | New plant | Awaiting financing; under order |
| F. W. & F. Carlisle Co. | Inorganic waste | Replacement | Planning initiated for connection to city sewer in lieu of replacement |
| Jackson & Church | Inorganic waste | New plant | Planning initiated for connection to city sewer in lieu of new plant |
| Swan Ice Cream Co | PEU*** | New plant | Planning initiated for connection to city sewer in lieu of new plant |
| Sebewaing | 800 | New plant | Planning initiated |
| Michigan Producers Dairy Co | 3,420 | New plant | Under order; planning initiated |
| Michigan Sugar Co | 21,800 | Enlargement | Under order; planning initiated |
| Sebewaing Brewing Co | 1,140 | New plant | Planning initiated |
| Standish | 981 | New plant | Under order; awaiting financing |
| Michigan Producers Dairy Co | 210 | New plant | Under order |
| St. Louis | 3,040 | New plant | Planning initiated |
| St. Louis Co-op Creamery Co | PEU*** | New plant | Planning initiated |
| Lake Shore Sugar Co | 58,000 | Enlargement | Under order; construction authorized |
| Vassar | 2,155 | New plant | Planning initiated |
| West Branch | 1,962 | New plant | Under order; planning initiated |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.
**Population equivalent for industry.
***PEU is abbreviation for Population Equivalent Undetermined.

## DETROIT AREA (LAKE HURON TO LAKE ERIE) SUB-BASIN

This sub-basin is comprised of all the area west of and tributary to the St. Clair River; Lake St. Clair; Detroit River; and Lake Erie between the mouth of the Detroit River and the Michigan-Ohio State line. The area, while irregular in outline, is more or less rectangular in shape, extending 140 miles along its northeast-southwest axis and 50 miles along its northwest-southeast axis. The sub-basin contains the most developed water front in the entire State of Michigan.

The drainage in this sub-basin is contained within the State of Michigan and covers over 5,000 square miles of that State. The highest elevation in the sub-basin is over 400 feet above the Detroit River. Numerous beach sites provide excellent opportunities for recreational sport; these sites, however, have been impaired because of pollution in the area. The St. Clair River, Lake St. Clair, Detroit River, and the western end of Lake Erie provide a continuous water front along the eastern edge of the sub-basin.

The principal rivers draining to this waterway are the Black, Clinton, Rouge, Huron, and Raisin. These rivers are from 32 to 80 miles long with a fall between 200 and 440 feet. The St. Clair River, Lake St. Clair, and the Detroit River form an exceedingly important waterway in the Great Lakes system and some of the tributaries like the Clinton, Rouge and Black are navigable for short distances above their mouths.

The sub-basin topography was largely formed during the glacial period and is relatively flat with some gently rolling hills in the higher regions. The area contains well over 300 lakes, many of which are larger than 200 acres in size. Glacial detritus has formed a fine tillable soil which supports a lucrative and extensive truck gardening industry around the Detroit metropolitan area. Sedimentary rocks underlying the area are 200 to 1,700 feet thick. Extensive beds of rock salt underlie the sub-basin from Trenton to Port Huron. These beds are 100 to 300 feet thick and are found nearly 2,000 feet below the surface of the ground.

Weather conditions in the region are greatly influenced by the close proximity of large bodies of lake water. The tempering effect of the water on climate is demonstrated by the fact that the growing season in this sub-basin is over two months longer than the season for interior counties of the north end of this peninsula. The average January temperature for the region is about 25°F. while the average July temperature is around 72°F. The average annual precipitation is 32 inches with nearly 60 percent falling during the warm season.

The sub-basin contains the largest population concentration in the State, which is the Detroit metropolitan area. The 1950 estimated population for the entire sub-basin is 3,285,000. Distribution of the population throughout the sub-basin ranges from 30 persons per square mile in Lenawee County to over 3,000 persons per square mile in Wayne County. In the sub-basin the important and large population centers of Port Huron, Detroit, Dearborn, and Wyandotte are found immediately adjacent to the waterway, emphasizing the importance of this waterway in the growth of these communities.

The automobile industry has been mainly responsible for the rapid industrial growth in the sub-basin during the past 30 years. This industry has brought about the development of many related activities such as coke production, tool and die manufacturing, steel mills and blast furnaces. Chemical plants, pulp and paper mills, distilleries, oil refineries and rubber processing plants are also important in the region's economy. Widespread growth of truck and dairy farming in adjacent areas has resulted in the establishment of many food processing plants such as canneries, dairies, and beet sugar refineries.

Nearly 3,000,000 persons were transported on vessels through the Detroit River-Lake St. Clair-St. Clair River waterway during 1947. The greatest concentration of vessel commerce occurred in the Detroit River, where total vessel passages were more than 28,000 and the net tonnage carried was 99,000,000 tons.

This report is concerned only with the pollution sources which are of American origin. However, pollution sources also exist on the Canadian side of the International boundary, which affect the condition of the waterway.

One hundred and twenty-one sewered municipalities serving about 3,500,000 people are located in this sub-basin. Of this number, 15 municipalities provide secondary treatment serving 166,000 people, and 65 municipalities provide primary treatment serving 2,900,000 people. Of the 41 municipalities which do not provide treatment, eight have populations less than 500, 11 have populations between 500 and 1,000, 13 have populations between 1,000 and 2,500, and nine have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by 86 industries, 56 of which have provided treatment for their wastes.

Table E 5 is an analysis of the adequacy of existing treatment facilities. This table indicates that 23 of the municipal and 13 of the industrial waste treatment plants have unsatisfactory capacity and that the operation should be improved at five municipal and six industrial waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in table G5. This shows that 34 new municipal plants are needed and that 18 existing plants need enlargement or additions. Five plants are reported to need replacement. It is also noted that 23 new industrial waste treatment plants are needed while 12 are in need of enlargement or additions. One existing industrial waste treatment plant, it is reported, needs to be replaced.

An analysis of the municipal waste treatment requirements of population groups shows the following distribution:

| Population group | New plant | Enlargement or additions to existing plant | Replace existing plant | Undetermined |
|---|---|---|---|---|
| Less than 500..... | 5 | 0 | 2 | 0 |
| 500 to 1,000 ... | 8 | 1 | 2 | 0 |
| 1,000 to 2,500 ... | 13 | 4 | 1 | 0 |
| Over 2,500 ... | 8 | 13 | 0 | 1 |
| Total.... | 34 | 18 | 5 | 1 |

Table F 5 reveals definite progress in construction of both municipal and industrial waste treatment plants. During the period 1946-1949, five municipal and 24 industrial waste treatment works were built. The municipal works served a population of 67,126 and the industrial waste treatment facilities treated wastes having a population equivalent of 259,000 persons in addition to inorganic wastes.

Table H 5 reveals another phase of pollution abatement progress in that five municipalities and five industries are under orders, while 20 municipalities and 22 industries are having plans prepared for waste treatment works. Final plans have been approved for ten municipal and three industrial waste treatment plants and four municipal and three industrial waste treatment works are under construction.

The significant water uses in the sub-basin are industrial and municipal water supply, navigation and recreation. Over 2,500,000 persons are served by municipal water supplies obtained from the waterway system. It is estimated that 1.4 billion gallons of water are used daily for various industrial purposes. Large segments of the population use the bathing beaches in the area to a very great extent and beach facilities are currently being expanded. In the Detroit area alone, 25,000 pleasure craft of 16-foot length or larger have been registered while many smaller boats are also used in these waters. Fishing is a year-around sport in parts of the section, where ice fishing is very popular. Commercial fishing in the American waters of the sub-basin has not been permitted since 1909. Many hunters are attracted to some areas of the sub-basin which are natural habitats for many kinds of waterfowl.

While some damage to the streams tributary to the waters of the international boundary has occurred, by far the most important pollution problem in the sub-basin exists in the waterway from Lake Huron to Lake Erie. Treated and untreated domestic sewage from nearly 30 American communities, as well as serious industrial pollution from chemical, automotive, gas manufacturing, metal processing and coke plants, contribute a staggering load to this waterway. These waters receive daily, from United States sources alone, 6,120 pounds of phenols; 3,690 pounds of cyanides; 11,065 pounds of ammonium compounds; 16,280 gallons of oil and 1,702,000 pounds of suspended solids. The population equivalent of organic industrial wastes discharged into these waters is 1,825,000 from American wastes alone. The total population equivalent reaching the waterway is 2,500,000. In addition pollution from vessels or allied navigational enterprises is discharged in the form of bilge water, ballast water, sanitary wastes and dredging deposits.

The Detroit area has a problem due to incomplete collection of sewage at Bates and Clark Streets and at the Southfield sewer. Plans have been completed for the Bates Street and Clark Street outlets and construction was scheduled to begin in 1950. Abatement has been ordered for the Southfield outlet to become effective in 1953. Abatement of pollution is also needed from the combined sewer overflows at the Fox and Connor Creek outlets.

Serious damage to all water uses in the international boundary waters has occurred. High bacterial counts have occurred in these waters from which municipal water supplies are drawn. A serious potential menace to the safety of these supplies exists and objectionable tastes and odors are commonly detected. The waters have been polluted to such a degree that they have become unsuited for use by certain industries and all recreational uses have been seriously impaired by the pollution. Considerable damage in the form of property value depreciation has occurred among water front property owners.

A recent report of the Board of Technical Advisors to the International Joint Commission

gives detailed consideration to all water uses and the various aspects of pollution of the boundary waters between Lake Huron and Lake Erie and contains recommendations for the improvement of these waters.

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (tables B and I), the population equivalent of the waste was used when known.

Table $A_5$. Sources of pollution, municipal

| Municipalities* | Sources of pollution (in number of municipalities)** | Population served by sewerage system | Amount of pollution discharged to watercourse (in terms of equivalent number of people)*** |
|---|---|---|---|
| Having data on pollution load discharged to watercourse | 3 | 7,600 | 4,400 |
| Having population data available (Data on pollution load to watercourse incomplete or not available) | 118 | 3,488,750 | Not applicable |
| Total | 121 | 3,496,350 | -- |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes all municipalities, etc. with sewer systems regardless of status of treatment or magnitude of the problem created. Reference to table C and E is necessary to determine number of municipalities with treatment and the adequacy of such treatment.

***Includes industrial wastes discharged into municipal sewerage systems.

Table $B_5$. Sources of pollution, industrial

| Industries | Sources of pollution (in number of plants)* | Amount of pollution discharged to watercourse (in terms of equivalent number of people) |
|---|---|---|
| Producing organic wastes | 30** | 987,060 |
| Producing organic wastes | 21 | Undetermined |
| Producing inorganic wastes | 48 | Not applicable |
| Producing wastes of undetermined type | 0 | Undetermined |
| Total | 86*** | -- |

*Includes all industries with outlets for the discharge of waste to the watercourse regardless of the status of treatment or magnitude of the problem created. Reference to tables D and E is necessary to determine the number of industries with treatment and the adequacy of such treatment.

**Includes 13 plants also producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus,**.

Table $C_5$.
Existing treatment facilities, municipal

| Degree of treatment provided | Number | | Population served |
|---|---|---|---|
| | Municipalities* | Plants | |
| Primary | 65 | 26 | 2,900,375 |
| Secondary | 15 | 15 | 166,233 |
| No treatment | 41 | -- | 429,742 |

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table $D_5$. Existing treatment facilities, industrial*

| Type industry | Number of plants | Number of industrial plants having: | | |
|---|---|---|---|---|
| | | Treatment facilities | No treatment facilities | Undetermined facilities |
| Food and kindred products.. | 17 | 10 | 7 | 0 |
| Textile mill products..... | 2 | 0 | 2 | 0 |
| Paper and allied products.. | 12 | 8 | 4 | 0 |
| Chemical and allied products..... | 24 | 15 | 9 | 0 |
| Products of petroleum and coal..... | 5 | 3 | 2 | 0 |
| Rubber products..... | 1 | 1 | 0 | 0 |
| Primary metal industries... | 3 | 3 | 0 | 0 |
| Fabricated metal products.. | 18 | 13 | 5 | 0 |
| Oil production industry.... | 4 | 3 | 1 | 0 |
| Total..... | 86 | 56 | 30 | 0 |

*Industries having separate outlets and discharging wastes directly to watercourse.

Table $E_5$. Adequacy of existing treatment facilities

| Existing treatment facilities | Number | Adequacy with relation to: | | | | | |
|---|---|---|---|---|---|---|---|
| | | Capacity | | | Operation | | |
| | | Satis-factory | Unsatis-factory | Unde-termined | Satis-factory | Unsatis-factory | Unde-termined |
| Municipal | 41 | 17 | 23 | 1 | 35 | 5 | 1 |
| Industrial | 56 | 35 | 13 | 8 | 44 | 6 | 6 |

Table $F_5$. Progress in pollution abatement

| Year | Municipal | | Industrial | |
|---|---|---|---|---|
| | Plants completed | Design population | Plants completed | Amount of waste treated (in terms of equivalent number of people) |
| 1946 | none | -- | 2 | 40,000* |
| 1947 | 1 | Undetermined | 3 | 214,000 |
| 1948 | 2 | 1,126 | 9 | 5,000** |
| 1949 | 2 | 66,000 | 10 | (***) |

*One industry discharged tar wastes.
**Four industries discharged oil wastes. One industry discharged pickling liquor wastes.
***Six industries discharged oil wastes. One industry discharged pickling liquor wastes. One industry discharged acids, alkali, cyanides and chromium wastes. One industry discharged phosphorus wastes. One industry discharged grease wastes.

Table $G_5$. Requirements for municipal and industrial waste treatment plants*

| Requirements | Municipal | | Industrial |
|---|---|---|---|
| | Number | Population served by facilities | Number |
| New plant | 34 | 425,997 | 23 |
| Enlargement or additions to existing plant | 18 | 2,901,720 | 12 |
| Replace existing plant | 5 | 3,345 | 1 |
| No project required ** | 24 | 65,288 | 39 |
| Undetermined | 1 | 100,000 | 11 |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**Includes seven municipal and four industrial minor sources of pollution not included in table $E_5$ for which existing disposal methods are considered satisfactory for present stream conditions.

Table $H_5$. Status of treatment works project to abate pollution, July 1, 1950

| Status of project | Number | |
|---|---|---|
| | Municipal | Industrial |
| No formal action | 10 | 6 |
| Abatement ordered | 5 | 5 |
| Plans under preparation | 20 | 22 |
| Final plans approved | 10 | 3 |
| Construction awaiting financing | 1 | 0 |
| Under construction | 4 | 3 |
| Status undetermined | 13 | 13 |

Table I5. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

| Name | Population served ** | Project requirements | Remarks |
|---|---|---|---|
| MICHIGAN | | | |
| Adrian | 17,000 | Enlargement | Awaiting financing; under order |
| Michigan Girls Training School | 300 | Replacement | Planning initiated |
| Sienna Heights School | -- | Replacement | -- |
| Algonac | 1,600 | New plant | Planning initiated |
| Almont | 925 | New plant | Plans approved |
| Ann Arbor | 43,815 | Enlargement | Under construction |
| Armada | 865 | New plant | Plans approved |
| Birmingham | 11,195 | Enlargement | Planning initiated |
| Blissfield | 2,140 | New plant | -- |
| Bloomfield Township | 1,000 | New plant | -- |
| Bloomfield Hills | 1,400 | New plant | -- |
| Capac: | | | |
| Capac Plastics, Inc | Not applicable | New plant | -- |
| Chelsea | 2,600 | Enlargement | Planning initiated |
| Chelsea Products, Inc | PEU*** | New plant | -- |
| Chelsea Spring Co | PEU*** | Enlargement | Planning initiated |
| Chelsea Steel Treating Co | PEU*** | New plant | Planning initiated |
| Longworth Plating Co | PEU*** | New plant | Planning initiated |
| Croswell | 1,380 | New plant | Plans approved; under order |
| Dearborn: | | | |
| (East Side) | 295,400 | Enlargement | Planning initiated |
| (West Side) | 25,000 | Enlargement | Planning initiated |
| Ford Motor Co. Rouge Plant | PEU*** | Enlargement | Planning initiated |
| Detroit (Metropolitan District) | 2,300,000 | Enlargement | — |
| Bates Street | PEU*** | New plant | -- |
| Clark Street | PEU*** | New plant | -- |
| Connor Creek | 250,000 | New plant | -- |
| Fox Creek | 85,000 | New plant | -- |
| Allied Chemical and Dye Corporation: | | | |
| Barrott Division | PEU*** | Enlargement | Planning initiated |
| Semet-Solvay Division | 39,900 | New plant | Planning initiated |
| Solvay Division | PEU*** | New plant | Planning initiated |
| Froedtert Grain and Malting Co | 4,000 | New plant | Planning initiated |
| Dundee | 1,700 | New plant | Plans approved |
| East Ann Arbor | 1,500 | New plant | Planning initiated |
| Ecorse: | | | |
| Great Lakes Steel Corp | PEU*** | Enlargement | -- |
| Murray Corp. of America | PEU*** | Enlargement | Plans approved |
| Farmington | 1,510 | New plant | Planning initiated |
| La Salle Winery Co | 4,140 | New plant | Planning initiated |
| Children's Convalescent Home | 1,000 | Enlargement | -- |
| Harrison Township(Macomb Co.) | PEU*** | New plant | Planning initiated |
| Lake Orion | 1,935 | New plant | -- |
| Lathrop Subdivision | 750 | New plant | -- |
| Lola Valley | 1,700 | Enlargement | -- |
| Manchester | 1,100 | New plant | -- |
| Marine City | 3,700 | New plant | Planning initiated |
| Marysville | 1,800 | New plant | Planning initiated |
| Morton Salt Co | 220 | New plant | Plans approved for sanitary waste |

See footnotes at end of table.

Table I5. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

| Name | Population served ** | Project requirements | Remarks |
|---|---|---|---|
| MICHIGAN--Continued | | | |
| Melvindale | 4,765 | New plant | Plans approved; under order |
| Milan | 2,340 | New plant | Plans approved |
| Milford | 1,640 | Enlargment | Planning initiated |
| Monroe: | | | |
| Consolidated Paper Co: | | | |
| (North side plant) | 191,700 | New plant | Planning initiated; under order |
| (South side plant) | 62,900 | New plant | Under order; under construction |
| River Raisin Paper Co | PEU*** | Enlargement | Planning initiated; under order |
| Mt. Clemens | 16,700 | New plant | Construction and authorized |
| Franklin County Sugar Co | PEU*** | Enlargement | Under order |
| New Baltimore | 800 | New plant | Plans approved |
| New Haven | 900 | New plant | -- |
| Palmyra: | | | |
| Simplex Paper Co | 5,850 | Enlargement | Construction authorized; under order |
| Pittsfield | 1,400 | Replacement | Planning initiated |
| Pontiac | 66,625 | Enlargement | Plans approved |
| Port Huron | 31,100 | New plant | Construction authorized; under order |
| Port Huron Sulphite and Paper Co | PEU*** | New plant | Planning initiated |
| Pressed Metals of America Inc | 800 | Enlargement | -- |
| Richmond | 1,725 | Enlargement | Planning initiated |
| River Rouge: | | | |
| Great Lakes Engineering Corp | PEU*** | New plant | Planning initiated |
| Rochester | 3,780 | Enlargement | -- |
| National Twist Drill Co | PEU*** | Enlargement | Planning initiated |
| Saline | 1,225 | New plant | Plans approved |
| Universal Products Co | PEU*** | New plant | Planning initiated |
| Sandusky | 1,510 | New plant | Planning initiated |
| St. Clair | 3,700 | New plant | Planning initiated |
| Diamond Crystal Salt Co | 500 | New plant | Sanitary waste |
| St. Clair Shores | 4,100 | Enlargement | Planning initiated |
| Southfield sewer outlet | PEU*** | New plant | -- |
| Tecumseh | 2,920 | New plant | Plans approved, under order |
| Trenton: | | | |
| Cycleweld Cement Products | Not applicable | New plant | -- |
| Utica | 1,020 | Enlargement | Planning initiated |
| Warren | 582 | New plant | Planning initiated |
| Center Line: | | | |
| General Motors Technical Center | PEU*** | New plant | Construction authorized |
| Wayne County (Parkway Plant) | 13,000 | Enlargement | Planning initiated |
| Wayne County (Wyandotte Plant) | 100,000 | Enlargement | -- |
| Weston: | | | |
| Page Dairy Co | 3,060 | New plant | Planning initiated |
| Wyandotte: | | | |
| Sharples Chemical Co | 9,500 | Enlargement | Planning initiated |

See footnotes at end of table.

Table I$_3$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

| Name | Population served ** | Project requirements | Remarks |
|---|---|---|---|
| MICHIGAN--Continued | | | |
| Union Carbide and Carbon Co. Halowax Products Division.. | -- | New plant | Inorganic waste; planning initiated |
| Yale..... | 1,500 | New plant | Planning initiated |
| Yale Woolen Mills..... | 10,480 | New plant | Planning initiated |
| Ypsilanti..... | 12,120 | Enlargement | -- |
| Zug Island: | | | |
| Great Lakes Steel Corp., Hanna Furnace..... | PEU*** | Enlargement | Planning initiated |

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.
**Population equivalent for industry.
***PEU is abbreviation for Population Equivalent Undetermined.

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